Engineering Library

OCT 15 1922

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXIII.—No. 2948.] *LONDON: FRIDAY, JUNE 30, 1922.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

Aveling & Porter, Ltd.,
ROCHESTER.
9663
Steam Road Rollers & Tractors.

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement pages 25 and 29.
PATENT WATER-TUBE BOILERS,
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C.2.
See half-page Advert. last week and next week. 675

Cranes.—Electric, Steam, HYDRAULIC and HAND, of all types and sizes.
GEORGE RUSSELL & CO., LTD., Motherwell, near Glasgow. 9948

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited, BIRMINGHAM. 7411
See Advertisement last week, page 87.

"Spencer-Hopwood" Patent WATER TUBE **Boilers.** *See page 80.* 577
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 9944

Cochran MULTITUBULAR AND CROSS-TUBE TYPES. **Boilers.**
See page 17. 9947

Petter Oil Engines.
For Paraffin and Crude Oil.
Sizes 1½ B.HP. and upwards.
Petters Limited, Yeovil.
Sizes 25 to 500 B.HP.
Vickers-Petters, Ltd., Ipswich
See advertisement alternate weeks. 9335

Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd.,
Newton Heath Glass Works,
Manchester. Oct 9758

Electric Cranes.
9663
S. H. HEYWOOD & CO., LTD., REDDISH.

Fuller, Horsey, Sons & Cassell.
SPECIALISTS in the SALE AND VALUATION of PLANT AND MACHINERY and ENGINEERING WORKS.
11, BILLITER SQUARE, E.C.3. 1834

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 8746
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 94, Robertson Street, Glasgow.
See Advertisement page 73, June 23.

Yarrow & Co. (1922), Ltd.,
SHIPBUILDERS AND ENGINEERS, GLASGOW.
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF EXCEPTIONAL SHALLOW DRAUGHT.
Repairs on Pacific Coast
by YARROWS, LIMITED, Victoria, British Columbia. 9563
SHIPBUILDERS, SHIP REPAIRERS AND ENGINEERS.

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

Vosper & Co., Ltd.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS. Oct 3551
ENGINEERS & BOILER MAKERS.

Cement.—Maxted & Knott, LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1890.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 9762

Oil Fuel Appliances, *Systems* PRESSURE, AIR, STEAM
For Boilers of all types.
KERMODES LIMITED, 35, The Temple, Dale Street, Liverpool.
Naval Outfits a Speciality, also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
Telephone No.: Central 2822.
Telegrams: "Warmth." 4078

Locomotives Tank Engines
designed and constructed by MANNING, WARDLE AND COMPANY, LIMITED, Boyne Engine Works, Leeds Oct 2487
See their Illus. Advertisement, page 97, last week.
RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Oct 3383

R. Y. Pickering & Co., Ltd.,
(ESTABLISHED 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS.
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices: WISHAW, near GLASGOW.
London Office: 3, VICTORIA STREET, WESTMINSTER, S.W. Oct 3353

Henry Butcher & Co.,
AUCTIONEERS, VALUERS AND SURVEYORS for ENGINEERING AND ALLIED TRADES and INDUSTRIAL PROPERTIES. 9686
63 and 64, CHANCERY LANE, LONDON, W.C.2.

Electric Transporters.
S. H. HEYWOOD & CO., LTD., REDDISH. 9663

John H. Wilson & Co., Ltd.,
Birkenhead.
See Illustrated Advertisement Page 100, Jan. 20, 1921.

Locomotive Shunting Cranes

Steam and Electric Cranes
EXCAVATORS, CRANE-NAVVIES, GRABS, CONCRETE-MIXERS,
SHIPS' WINDLASSES, WINCHES, and DECK MACHINERY. 637
LISTS OF STANDARD SIZES ON APPLICATION.
London Office: 15, VICTORIA STREET, S.W.1.

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
GENERAL CONSTRUCTIONAL ENGINEERS,
Boilers, Tanks, & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETED STEAM AND VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Tubes and Fittings.
Stewarts and Lloyds, Ltd.,
Glasgow and Birmingham.
See Advertisement page 102. 9663

Economy!
HIGH BOILER EFFICIENCIES ARE OBTAINED BY INSTALLING
Todd Oil Burners
FUEL OIL BURNING SYSTEMS, HEATERS, STRAINERS.
49-51, EASTCHEAP, LONDON, E.C. 3.
TODD SHIPYARDS CORPORATION, Builders of Steam and Motor Ships, Repairers, Electric Drive Installations.
Twenty-one Floating Docks, Two Graving Docks, Twelve Shipways.
25, Broadway, New York, U.S.A. 9660

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 540

FOR **Drop Forgings** write
GARTSHERRIE ENGINEERING & FORGE CO., 50, Wellington Street, Glasgow. 9674

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 191, LEADENHALL ST., E.C.3.
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice Making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c. &c. 9604

Electric Lifts
(UP TO 35 TONS.)
9663
S. H. HEYWOOD & CO., LTD. REDDISH.

Hardening & Heat Treatment.
Any class of tools. H. S. Chasers for adjustable die heads. Case hardening, colouring, etc. We can case harden Cast Iron for gauges, press tools, etc. Write us for particulars. Reliable Work | Right Prices | Delivery to promise |
OWEN & CRISP,
Engineers and Engineers' Agents,
64, Basinghall Street, London, E.C. 2.
Telephone:—London Wall 5686. 9630

Diesel Engines, Six Cylinder,
Two and Four stroke, 350, 1000, 1200 H.P., excellent condition. Dynamos for above 250 or 500 volts, D.C. Immediate delivery and low price.
Two 500 Kw. Parsons Turbine Sets, 250 or 500 volts, D.C., with condensing plant and spare armature. Price £2250.
Electrical driven Centrifugal, Ram and other Pumps from 1½ in.-10 in. outlet.
JENNINGS, 9742
West Walls, Newcastle-on-Tyne.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM AND GAS KETTLES, Merrill's Patent TWIN STRAINERS for Pump Suctions. } ROYLE'S PATENTS.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 8722

Yarrow Patent Water-tube Boilers. 9664
Messrs. YARROW & CO., UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO. (1922), LTD., SCOTSTOUN, GLASGOW.

Matthew Paul & Co., Ltd.
LEVENFORD WORKS, **Dumbarton.** 769
See Full Page Advt., page 88, June 23.

Forgings.
Walter Somers, Limited, HALESOWEN. 7116

Taylor & Challen Presses
About 200 NEW PRESSES in Stock in our Showrooms for immediate delivery at specially Reduced Prices. 8195
TAYLOR & CHALLEN, LTD., Engineers, Constitution Hill, BIRMINGHAM.
See Full page Advertisement, page 59, June 23.

"Delta" Brand HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., LTD., 631
E. GREENWICH, LONDON, S.E. 10 (& at Birmingham)

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 650

A. P. Thurston, D.Sc. Engineering. Expert advice on Patents, Inventions, Models and Designs.—39, Southampton Buildings, W.C. 2. Holborn. 2543. 9661
'Phone—Holb. 541. Tele—Andrube, Holb., London.

Andrews & Beaumont,
CHARTERED PATENT AGENTS, 676
29, Southampton Buildings, London, W.C. 2.

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON AND BRASS CASTINGS, PRESSED STEEL WORK OF ALL KINDS.
Registered Office and Chief Works: Motherwell.
London Office: 14, Leadenhall Street, E.C. Oct 3383

Locomotive Traversers
(ELECTRIC). 9663
S. H. HEYWOOD & CO., LTD., REDDISH.

P. & W. MacLellan, Limited,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices; 120, Trongate, GLASGOW. Oct 3547
Registered Offices: Clutha House, 10, Princes St., Westminster, London, S.W.1.

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND. 9737
See half-page Advertisement page 66, June 9.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 566

The Institute of Physics.

LECTURES ON "PHYSICS IN INDUSTRY."

The SECOND LECTURE of this series entitled "The Physicist in Engineering Practice with Special Reference to Applications of Thermodynamics," will be delivered by SIR J. ALFRED EWING, K.C.B., F.R.S., on TUESDAY, JULY 4TH, 1922, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Sir Charles Parsons, K.C.B., F.R.S., will preside.

F. S. SPIERS,
Secretary.
10, Essex Street, W.C. 2. U 565

Finsbury Technical College,

LEONARD STREET, CITY ROAD, E.C. 2.

Dean for the Session, 1921-22.
PROFESSOR W. H. ECCLES, D.Sc., F.R.S.

The College provides practical scientific training for students who desire to become Civil, Mechanical or Electrical Engineers, or Chemists.

Candidates are required to pass an Entrance Examination in Mathematics and English, but the Matriculation Certificate of any British University, and certain other qualifications, are accepted in lieu of it. The next ENTRANCH EXAMINATION will be held on TUESDAY, SEPTEMBER 19th. Applications for admission should be forwarded to the College on forms to be obtained from the REGISTRAR. The Programme of the College is under revision and will be issued shortly. U 480

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), and ALL ENGINEERING EXAMINATIONS personally conducted by MR. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 575

Inst. C.E., I. Mech. E., B.Sc.,

and all Engineering Examinations.—Mr. G. P. KNOWLES, B.Sc., M.E.E., A.M.Inst.C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Thousands of successes during the last sixteen years. Courses may commence at any time.—39, Victoria St., Westminster, S.W. Tel. 4780 Victoria. 745

Inst. C.E. Exams.—Successes

as usual last Exam. by Correspondence Coaching. Successes by hundreds, several prizes. Sec. "G" embraces 26 years' professional experience. Address, 7434, Offices of ENGINEERING.

Powering of Vessels.—A

Practical Course of Instruction by Correspondence.—Address, for particulars and terms, 748, Offices of ENGINEERING.

Bridge Stresses.—A Civil

Engineer gives instruction by post in the computation of stresses and design of steel and wooden structures.
Address, U 604, Offices of ENGINEERING.

TENDERS.

THE HIGH COMMISSIONER FOR INDIA is prepared to receive

Tenders for the Supply

of:
1. BRIDGEWORK, Deck Spans.
2. LOCOMOTIVE ENGINES and TENDERS.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere Road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m., on Tuesday the 18th July, 1922, for No. 1, and on Friday, the 21st July, 1922, for No. 2.

T. RYAN,
Director-General.
U 614

STATE ELECTRICITY COMMISSION OF VICTORIA.

TENDERS FOR PLANT.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification, will be available upon application to:—
AGENT-GENERAL FOR VICTORIA,
Melbourne Place,
Strand,
London, W.C. 2.

SPECIFICATION No. 261:—
STRAIN AND PIN TYPE INSULATORS.
CHARGE:—
£3 3s. for the first three copies of Tender Form, Conditions of Contract, Specification and Drawing complete. These charges will be returned on receipt of a *bona fide* tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each.
PRELIMINARY DEPOSIT:—
A Preliminary Deposit of £100 is to be lodged with Tender.
The Specifications may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any tender.
Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne, not later than Noon, 16th September, 1922:—

R. LIDDELOW, Secretary,
STATE ELECTRICITY COMMISSION OF VICTORIA,
MELBOURNE,
Victoria, Australia. U 574

LONDON COUNTY COUNCIL.

Tenders are Invited for the

MANUFACTURE, SUPPLY, DELIVERY, ERECTION, TESTING and MAINTENANCE of FOUR ELECTRIC LIFTS, for the Council's Tramways Central Repair Depot, Charlton, S.E.
The Specification, Form of Tender, and other particulars may be obtained from the Clerk of the Council, County Hall, Westminster Bridge, S.E. 1, on payment to the Cashier of the Council of a deposit of £2, which amount will be returnable on receipt of a *bona fide* Tender which is not withdrawn. Particulars of the work may be obtained on application at the County Hall before payment of the fee.
Tenders must be addressed to the Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E. 1, not later than Four p.m., on Monday, 31st July, 1922. No Tender received after that time will be considered.
The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD, U 611
Clerk of the London County Council.

TO ENGINEERS AND OTHERS.
THE METROPOLITAN ASYLUMS BOARD Invite separate

Tenders from Thoroughly

Reliable Firms, who have executed works of a similar character, for:—
(A) The INSTALLATION of INTERNAL AUTOMATIC TELEPHONES at the River Hospitals, near Dartford, Kent,
(B) The INSTALLATION of ELECTRIC LIGHTING in Ward Blocks, Boiler House, etc., at the Grove Fever Hospital, Tooting, S.W. 17,
(C) The INSTALLATION of a CONTINUOUS DRYING MACHINE, at the Southern Hospital, near Dartford, Kent,
(D) The INSTALLATION of a BRICK-BUILT BAKERS' OVEN at the North-Western Fever Hospital, Lawn Road, Hampstead, N.W. 3, each in accordance with Drawings and Specification prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mech.E., Engineer in Chief. The Drawings, Specifications and Forms of Tender may be inspected at the Office of the Board, Embankment, E.C. 4, on and after Ten a.m. on Friday, 30th June, 1922, and can then be obtained upon payment of a deposit of £1 in respect of each work. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender sent in accordance with the instructions on the Form of Tender, and after the Specification and the Drawings have been returned.
Tenders addressed as noted on the Form must be delivered at the Office of the Board not later than 2.30 p.m. on Wednesday, 19th July, 1922.
(By Order),
G. A. POWELL,
Deputy Clerk to the Board. U 598

NEWPORT (MON.) CORPORATION WATERWORKS.
TALYBONT SCHEME. CAST IRON PIPES.
CONTRACTS Nos. 1 and 2.
The Waterworks Committee invite

Tenders for the Supply of

CAST-IRON PIPES in two Contracts as follows:—
No. 1. About 11,000 tons 25 in. in dia. and a small quantity of lesser diameters.
No. 2. About 11,000 tons 25 and 19 in. in dia. and a quantity of other sizes.
Separate Specifications and Forms of Tender may be obtained and Drawings inspected at the office of the Engineers, G. H. HILL & SONS (Westminster), 3, Victoria Street, Westminster, on payment of £2 in each case, which will be refunded to the applicant provided he shall have sent in a *bona fide* Tender, shall not have withdrawn the same and shall have returned the Documents and Drawings lent to him. The said sum will also be returned to any applicant who decides not to tender, if the Documents and Drawings are returned within a week of their issue to him. A limited number of sets of the Drawings are available for lending to persons who have applied for the Specifications, and will be lent to such persons in priority of application on payment of the sum of one pound for each set, which sum will not be returned. Separate sealed Tenders, endorsed "Talybont Scheme, Tender for Contract No. 1" or "No. 2," as the case may be, and addressed to the undersigned, must be received not later than Saturday, the 22nd July.
The Committee do not bind themselves to accept the lowest or any Tender.
The Contractor will be required to pay Trades Union rate of wages and observe the recognised hours and rules of labour.

ALBERT A. NEWMAN,
Town Hall, Newport, Mon. Town Clerk.
26th June, 1922. U 595

NEWPORT (MON.) CORPORATION WATER WORKS.
TALYBONT SCHEME, CONTRACT No. 3, VALVES, BRIDGEWORK, ETC.
The Waterworks Committee invite

Tenders from Experienced

Makers of Valves for Waterworks Purposes for the SUPPLY of AUTOMATIC STOP VALVES, SLUICE VALVES, AIR VALVES, REFLUX VALVES, REDUCING VALVE, FLAP VALVES, and Miscellaneous Ironwork, also SMALL BRIDGEWORK, all in connexion with a line of piping, chiefly 26 inches in diameter and about 34 miles in length. The bridgework may be sublet. Specification and Form of Tender may be obtained and drawings inspected at the office of the Engineers, G. H. HILL & SONS (Westminster), 3, Victoria Street, Westminster, upon payment of two pounds, which will be returned to the applicant provided that he shall have sent in a *bona fide* Tender, and shall not have withdrawn the same, and shall have returned the documents and drawings lent to him. A limited number of sets of the drawings (uncoloured) are available for lending to persons who have applied for the specification, and will be lent to such persons in priority of application on payment of the sum of two pounds, which sum will not be returned. Sealed Tenders endorsed "Talybont Scheme, Tender for Contract No. 3," and addressed to the undersigned, must be received by me not later than Saturday, the 22nd July.
The Committee do not bind themselves to accept the lowest or any Tender.
The Contractor will be required to pay Trades Union rate of wages and observe the recognised hours and rules of labour.

ALBERT A. NEWMAN,
Town Hall, Newport, Mon. Town Clerk.
26th June, 1922. U 596

APPOINTMENTS OPEN.

UNIVERSITY OF GLASGOW.

CHAIR OF MINING.

The University Court Pro-

poses to consider the making of an APPOINTMENT to FILL the VACANT CHAIR on 21 July next or later date.
Information regarding the Chair may be obtained on application to the SECRETARY of the University Court, The University, Glasgow.
June, 1922. U 577

WORKS MANAGER.

Wanted, for Six-Mill Tinplate

Plant in India, a TECHNICAL WORKS MANAGER. A man with sound practical training and wide experience, age preferably not over 45, capable of supervising European staff and native labour, is required. Applicants should state age and experience with full details of training and positions held, and submit references. Engagement will be for four years with renewal by mutual arrangement.—Apply, BOX 66, SHAW & BLAKE, Ltd., 31, Surrey Street, Strand, W.C. 2. U 579

Wanted, Advertisement and

PUBLICITY EXPERT, to prepare Catalogues, Circulars, Advertisements, Announcements, etc. Steam, Electric and Mining experience desirable.—Applications, stating age, full experience and salary required must be made on sheets written on one side only, in envelopes marked in left hand top corner "A.P.X.," addressed to ROBERT A. HOPKINSON, Chairman and Managing Director, Messrs. J. Hopkinson & Co., Ltd., Makers of Patent Safety Boiler Mountings and Valves, Britannia Works, Huddersfield. U 567

CIVILIAN EDUCATIONAL STAFF—ROYAL AIR FORCE.

Applications are Invited

for VACANT APPOINTMENTS as EDUCATION OFFICERS, Grade III and Grade IV, on the Educational Staffs of the undermentioned establishments:—

Boys' Wing, Royal Air Force, Cranwell, near Sleaford, Lincolnshire.	Grade III
No. 1 School of Technical Training (Boys), Halton, near Wendover, Bucks.	Grade III
Electrical and Wireless School, Flower Down, near Winchester (Airmen and Boys).	Grades III and IV
School of Technical Training (Men), Manston, near Ramsgate.	Grades III and IV
R.A.F. Depot, Uxbridge (Airmen).	Grades III and IV

The salary scales, to which Civil Service Bonus will be added, are given below. These scales are provisional and are now being reconsidered. Allowances up to ten increments of the scale can be made for previous experience and war service. Preference will be given to candidates who have served as commissioned officers in any of the three Services. The principal subjects of instruction are English, Practical Mathematics, Applied Mechanics and Drawing.

Grade III (Graduate)	£150-10-200-15-£350	With current Civil Service bonus, approximately £374-£553.
Grade IV	£110-10-£275	£214-£450.

Applications must be made on A.M. Form 69, which, together with further particulars, can be obtained from the SECRETARY, A.E., Air Ministry, Kingsway, London, W.C. 2. U 621

SINGAPORE, STRAITS SETTLEMENTS.
WATER DEPARTMENT.
ASSISTANT SUPERINTENDENT OF WATER MAINS AND SERVICES.
The Municipal Commissioners of Singapore require an

Assistant Superintendent of

Water Mains and Services, age about 27 to 33 (preferably unmarried), on a three years' agreement, with possible extension. Applicants must have had a good education, be well trained and have had special practical experience in the laying of Water Mains and outside Water Fittings, as well as internal plumbing. They must be "Registered Plumbers," with experience in the work of a mains and services department under a water authority in the United Kingdom, and must be accustomed to carrying out the model by-laws and regulations. They should be accustomed to controlling men, and experience in a workshop and in training men will be an advantage, as the successful candidate would be required to instruct the native subordinate staff in the practice and requirements of modern internal plumbing for public and private buildings. He would also be required to supervise such work in accordance with standard regulations, whether executed by outside contractors or by municipal workmen. A bonus of $50 will be given on the selected candidate's passing successfully an examination in colloquial Malay within twelve months of his arrival in Singapore. Salary $4560 for the first, $5040 for the second, and $5520 for the third year, paid monthly, in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. In addition there is a Temporary Allowance of 15 per cent., which may be reduced or abolished at any time. If re-engaged, the candidate, in his fourth year, would probably be placed in class 5 of the salary scheme, at a commencing salary of $6000 per annum (£700), rising by annual increments of $480 to $7440 (£868) per annum, with any temporary allowance that might then be in force. The pay of the appointment for the first year at the above rate would be about £611. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free second-class passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination. — Applications, stating whether married or single, age, and place of birth, and giving details of education, apprenticeship, training, and experience generally, with war service, and referring to the above requirements in detail, accompanied by copies (only) of testimonials, and also personal references, are to be lodged with Messrs. C. C. LINDSAY & PEIRCE, M.M.Inst.C.E., 180, Hope Street, Glasgow, Agents to the Commissioners (who will give further particulars if requested), not later than Thursday, 6th July, 1922. U 607

Wanted, a Technical Expert

to advise on new plant for the manufacture of Sheet Glass.—Full particulars to W. J. PERKINS, A.M.Inst.C.E., M.I.Mech.E., Consulting Engineer, 26, Victoria Street, Westminster, S.W. 1. U 561

Required by Old-established

Engineering Firm in India, SALESMAN for their Hardware and General Engineers, Stores Department, aged about 25 and single.—Reply, giving full details of experience, stating age and salary required, Z.R. 886, care of DEACON'S, Leadenhall Street, London. U 603

Required by Old-established

Engineering Firm in India, OIL MILL MACHINERY SALESMAN who must have expert and up-to-date knowledge both in theory and the practical running of such machinery.—Reply fully, stating experience, age, whether married or single and salary required, Z.P. 885, care of DEACON'S, Leadenhall Street, E.C. U 602

Firm of Engineers, Founders,

Merchants and Agents in India, HAVE an OPENING for ASSISTANT to Managing Director, who, at times, would have to take control of business, fully qualified mechanical engineer, one with foundry and electrical knowledge preferred, who could take part in the salesmanship and commercial side of the business. Must be well educated and of good manners and excellent character. State experience.
Address, U 564, Offices of ENGINEERING.

Automobile Engineer, Fully

qualified, WANTED for service in West Africa; must be experienced in all repair work and maintenance American lorries.—BOX C 248, Iza AND NIGHTINGALE, Advt. Offices, Liverpool. U 571

Wanted, an Experienced

ROPEWAY ENGINEER, capable of laying out plants on all systems and with full experience of design and detail of all parts.—Applications giving experience and salary, to be made to U 608, Offices of ENGINEERING.

Engineer Required for

Municipal Waterworks in China. Candidates should have good technical training and previous waterworks experience; some knowledge of alternating current desirable. Age about 30. Applications, stating physical fitness, etc., together with qualifications and testimonials, by letter only, to "H.K.," care of J. W. VICKERS & Co., LTD., 5, Nicholas Lane, E.C. 4. U 587

UNIVERSITY OF CAPE TOWN.

DEPARTMENT OF CIVIL ENGINEERING.

Wanted, by 1st October, or

as soon after as possible, a FIRST GRADE MECHANICAL ASSISTANT in the Civil Engineering laboratory. Applicants must be good mechanics and have had satisfactory workshop experience. The duties of the position are to work and repair the testing and hydraulic equipment in the laboratory, to lay down new plant, to make test specimens and accurate experimental apparatus and, generally, to work under the instructions of the Professor. Experience in turning, fitting and fine instrument work is essential.
Salary £350 a year rising to £450 by annual increments of £25. The appointment is probationary for the first two years. An allowance of £40 will be made for passage money; pension rights are secured under the Government Teachers Superannuation Fund, membership of which is compulsory; six months' leave of absence may be granted after six years service, three months of which will be on full pay.
Applications in triplicate should be sent to the SECRETARY, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, not later than 15th July, 1922. U 576

BOMBAY MUNICIPALITY.

Required, One Mechanical

ENGINEER AND THREE ASSISTANT MECHANICAL ENGINEERS to supervise the manufacture of 72 in., 60 in. and 57 in. diameter Steel Pipes in the Workshops near Bombay, and the assembling and laying of the same along 60 miles of pipe track outside Bombay.
All Applicants should be between 25 and 45 years of age.
The Mechanical Engineer should have had a good technical education and considerable practical experience in structural steel work, boiler making, &c., and have held a responsible position as Works' Manager, Shift Engineer or similar post, in a shipyard, railway or large commercial firm.
Assistant Engineers should have had similar experience in a less responsible position such as Works' Foreman or Foreman Boiler Maker, &c.
The salary for the Mechanical Engineer is Rs. 1500 per month without quarters. The salary for the Assistant Engineer is Rs. 800 per month with tent or quarters and simple furniture; no accommodation is provided for wife or family.
All the appointments are temporary, but are not expected to terminate within three years.
The salary will commence from date of joining appointment in Bombay, and single first-class rail fare to Bombay will be paid to applicants selected from India.
Single first-class P. & O. passage from London to Bombay for the Mechanical Engineer, and second-class P. & O. passages for the Assistant Engineers will be provided if applicants are selected from the United Kingdom, with half salary on voyage.
Similar return passages and half salary on voyage being allowed on satisfactory completion of their duties.
All appointments are subject to three months notice on either side.
All selected candidates will be required to furnish a Medical Certificate of sound health and constitution prior to engagement. They will be entitled to leave according to the Municipal Leave Rules.
Selected candidates will be required to enter on their duties in Bombay early in December, 1922.
Applications, stating age, qualifications and experience, together with copies of testimonials, should be addressed to the undersigned, and will be received up to 31st August, 1922.

H. J. TRIVESS SMITH, M.I.C.E.,
Hydraulic Engineer,
c/o Messrs. HENRY S. KING & Co.,
9, Pall Mall, London, S.W. 1. U 606

10,000 KW. STEAM TURBINE FOR THE WEST HAM CORPORATION.

CONSTRUCTED BY MESSRS. BELLISS AND MORCOM, LIMITED, ENGINEERS, BIRMINGHAM.

(*For Description, see Page* 803.)

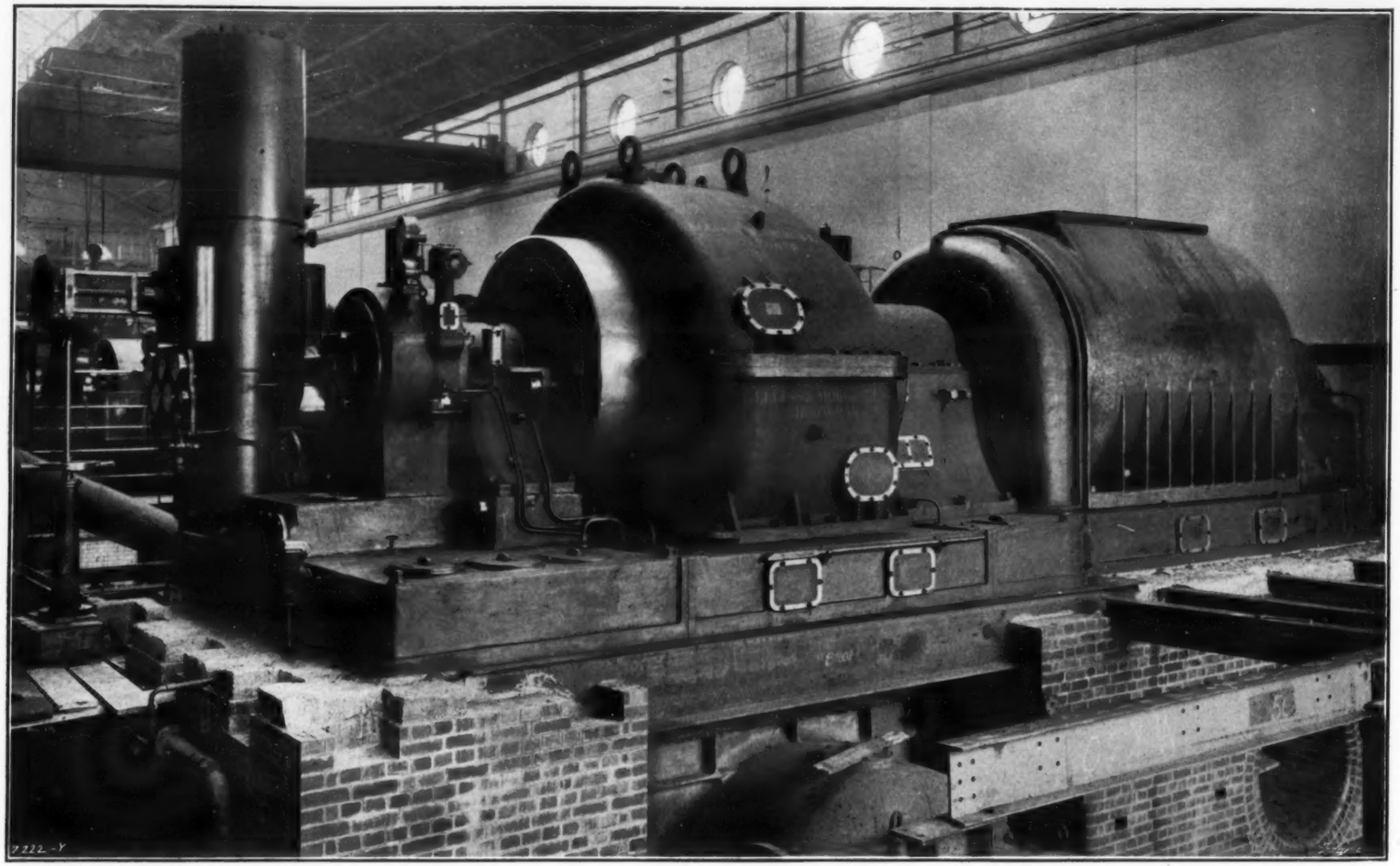
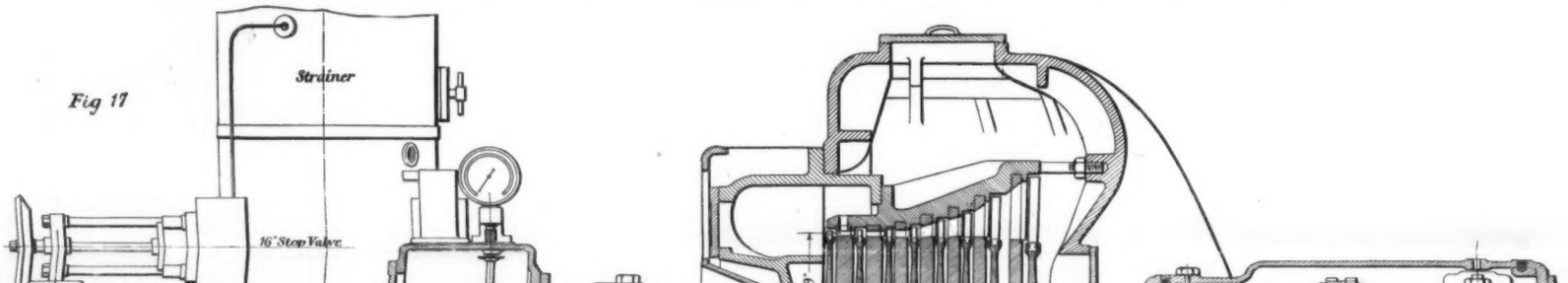


FIG. 16. BELLISS AND MORCOM STEAM TURBINE: 10,000 KW. AT 3,000 R.P.M. FOR THE WEST HAM CORPORATION.

Fig 17



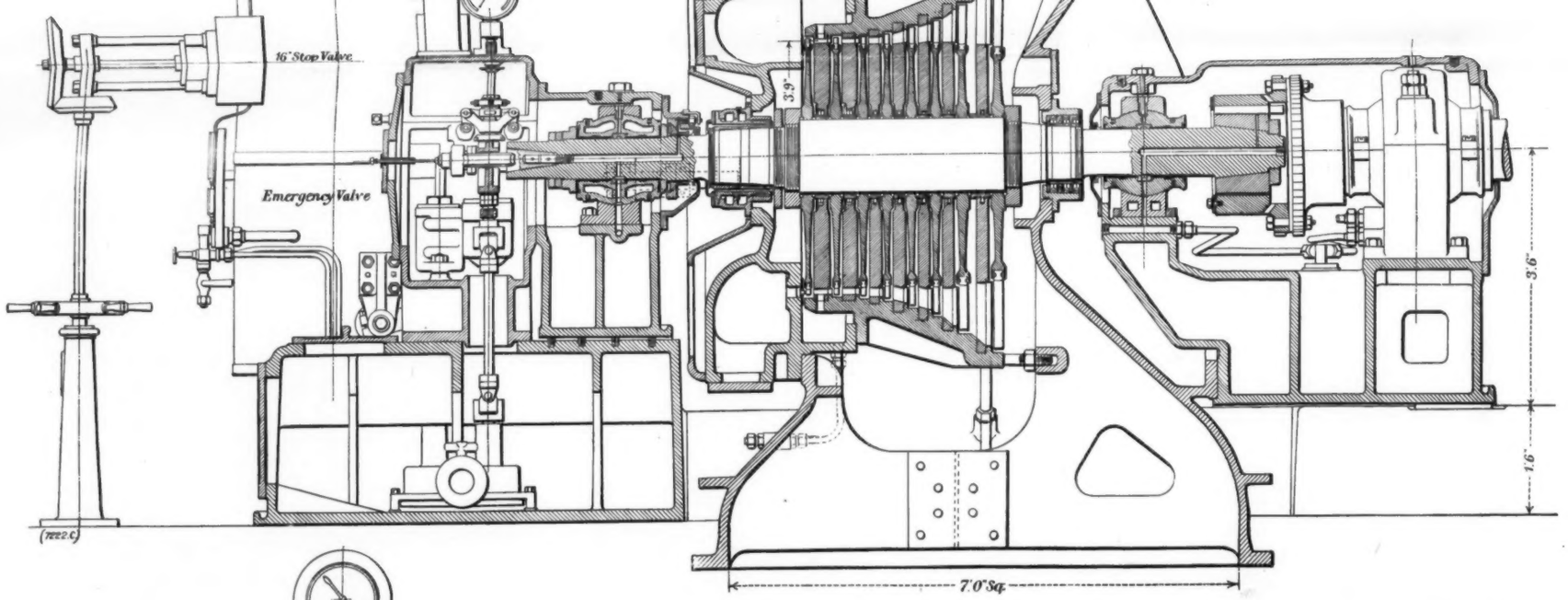


Fig 18.

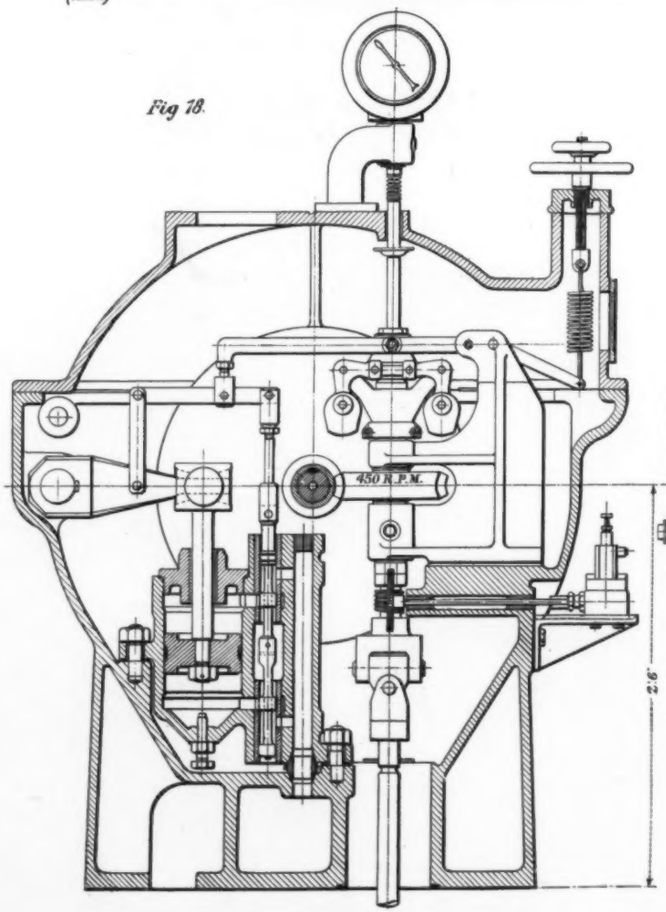


Fig. 19.

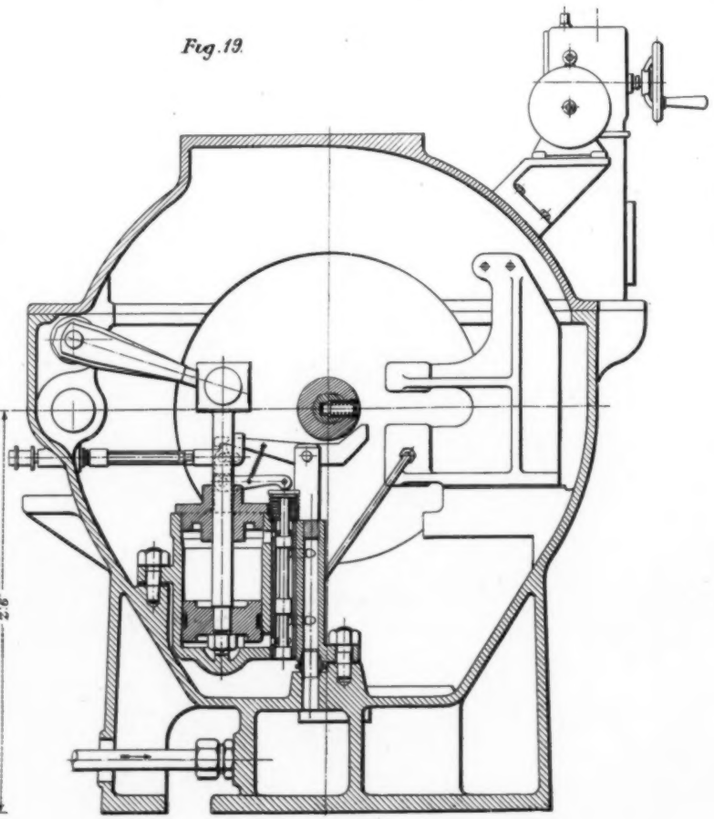


Fig. 20.

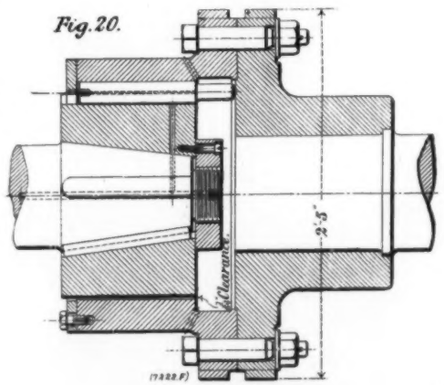
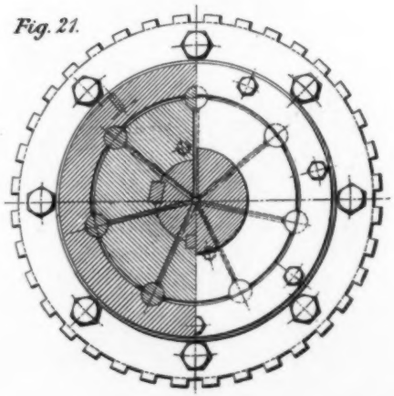


Fig. 21.



THE BELLISS AND MORCOM STEAM TURBINES.

(*Concluded from page* 776.)

THE turbine illustrated in Figs. 16 to 21, on Plate XLV, is one with a rated capacity of 10,000 kw. at 3,000 r.p.m., recently constructed by Messrs. Belliss and Morcom, Limited, to the order of the West Ham Corporation. It is notable as being one of the first machines to be constructed in this country or abroad designed to develop so high an output at 3,000 revolutions. As will be seen from the illustrations, the makers have retained the feature of the continuous bedplate which marks their designs for smaller machines. The turbine itself is of the eight-stage straight impulse type, no velocity compounding being resorted to. The mechanical features of the turbine itself are not greatly different from those of the machine previously described, and we therefore need not dwell upon them. The mechanism in the governor box, the nature of the flexible coupling and other details, are, however, very interesting. From Figs. 17, 18 and 19 the general arrangement of the governor-box mechanism will be understood, and in Fig. 24, on the present page, a photograph of the assembled parts is reproduced. The complete enclosure of all moving parts, their ample lubrication and the ready access to them which is available by removing the cover of the box are all features worthy of note.

At the high-pressure end, the turbine shaft is made with a tapered axial hole in the end, which serves to register accurately a tail-piece held in by a slightly flexible screwed end. This tail-piece carries the worm and emergency governor, and the feature of this removable end permits the whole rotor to be lifted out if desired without disturbing any of the governor gear. Similarly the worm which drives the governor and the emergency stop can be removed for examination without disturbing the rotor. The governor is carried by a bracket bolted on to a seating in the box. It is of the bell-crank lever type with tension springs directly connecting the balls on each side. The bracket also forms a fulcrum for the lever by which the governor actuates the oil relay, the end of the lever on the other side of the fulcrum being attached to a spring by which the speed is regulated. The arrangement will be best understood from Fig. 18, in which wheels are shown for hand control and locking, respectively. Hand control may, of course be replaced by a small electric motor operated from the switchboard, which is a great convenience when putting a machine in parallel or when it is desired to adjust the load between different machines. The motor control is illustrated in Fig. 24.

The motor drives a double worm gear, on the secondary wheel shaft of which is a crank to which the top end of the speed-adjusting spring mentioned above is linked. With this arrangement no limit switches and electrical complications are needed, for if over-run, "fast" becomes "slow" again. The motor is nevertheless provided with a "fast" and "slow" reversing switch since the ordinary control range is well within a half turn of the crank.

When the speed of the turbine increases the action of the governor is to pull down the fulcrum rod already mentioned, and so to cause the piston valve of the oil relay to be lowered. Oil is thus admitted to the top side of the large piston which operates the steam valve, and is permitted to escape from the bottom side of the piston. The latter consequently falls, and in so doing reduces the steam supply to the turbine. As it falls, however, the linkwork attached to the lever which works the steam valve acts on the piston valve in such a manner that the whole governor gear is rendered isochronous, the turbine being maintained at its normal speed and the relay valve at neutral in spite of the fact that the steam valve controlled by the governor is in a different position. It will be seen from Fig. 17 that the upward extension of the governor spindle drives the tachometer while the lower end drives the oil pump in the bedplate by means of a cardan shaft. This latter drive avoids any trouble in connection with the maintenance of exact alignment of the oil pump with the governor.

The emergency governor, the mechanism of which is shown in Fig. 19 is situated outside the main governor gear. The emergency governor itself consists of a steel ring mounted on the tail shaft. This ring is eccentrically bored, but is normally held central with the tail shaft by a spring as shown in Fig. 19. The eccentric hole, of course, puts it out of balance, and at a predetermined speed its centrifugal force overcomes the compression of the spring and the heavy side of the ring moves outwards. It then strikes a lever which unlatches a catch so that the piston valve shown can move upwards under the pressure of its spring and admit oil above the large piston. The same result can be obtained by pulling outwards the rod extending through the casing, so that the turbine can be tripped instantaneously by the operator should he desire to do so in an emergency. The time occupied between the emergency governor striking the catch-lever and the emergency valve being shut is only 0·52 seconds as measured by the Swinburne electro-pneumatic chronometer. On the cover of the governor box is a thrust indicator, or rather a longitudinal position indicator (see Fig. 17). This consists of a button held just off contact with the shaft end by means of a spring. The outside end has a finger button and a multiplying indicator, so that the attendant by pressing the button into contact with the shaft, can note and record the fore and aft position of the shaft at any time.

In very large turbines, such as the West Ham

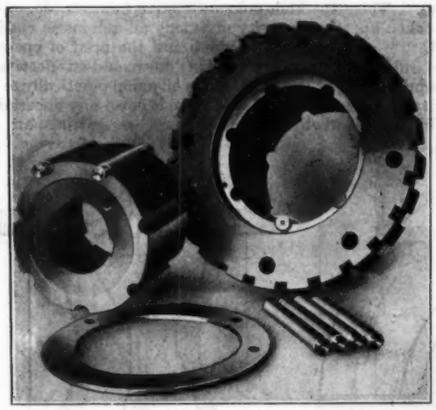


FIG. 22. PARTS OF FLEXIBLE COUPLING.

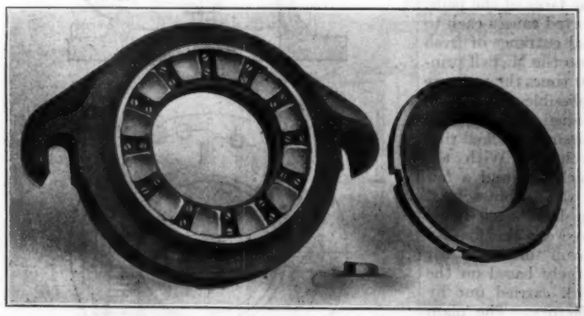


FIG. 23. MICHELL THRUST BEARING.

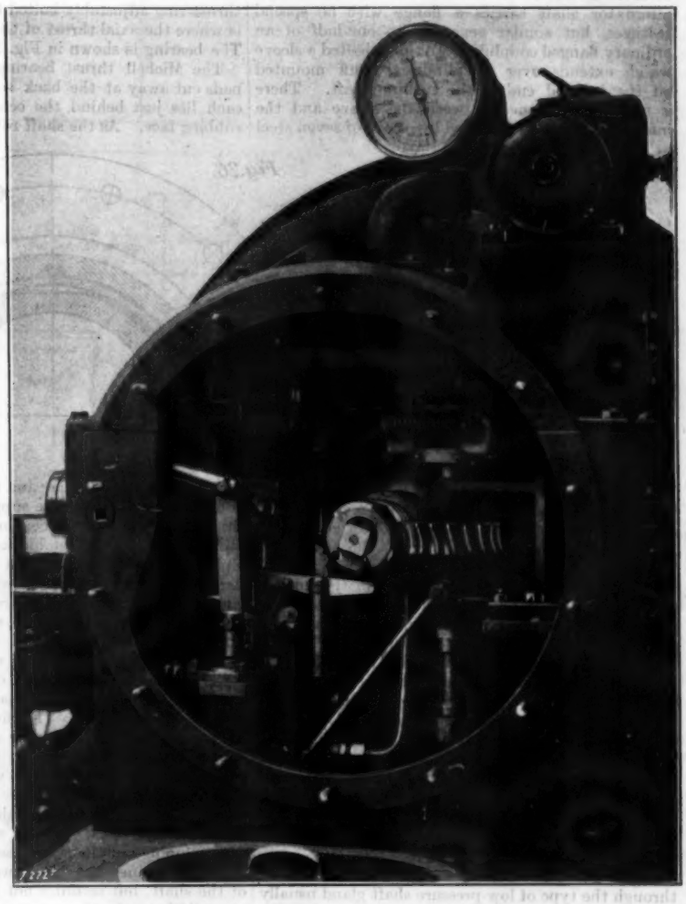


FIG. 24. GOVERNOR BOX WITH COVER REMOVED.

set, Messrs. Belliss and Morcom employ the familiar double-beat form of valve as an emergency valve, but in sizes up to 4,000 kw. the type shown in Figs. 27 and 28 is used. This, when open, causes hardly any resistance to the flow of steam, as the valve and seating are so shaped as to facilitate stream line flow. The valve itself is little more than half the diameter of the pipe, and the valve body takes up practically no more space than a corresponding length of straight steam pipe. Thus the valve can be neatly arranged in connection with the turbine.

The flexible coupling used to connect the turbine and alternator shafts is shown in Figs. 20 and 21, on Plate XLV, and Fig. 22, on page 803. It is of a specially simple type, but has proved satisfactory after long service in turbines of all sizes. The alternator shaft carries a flange with no special features, but similar generally to one-half of an ordinary flanged coupling. To this is bolted a sleeve which extends over a cylindrical muff mounted on the tapered end of the turbine shaft. There is a slight clearance between the sleeve and the muff, and driving is effected by means of seven steel pins lying in grooves formed in the opposing surfaces. The pins are prevented from escaping endwise by a ring fastened by set screws to an outer end of the sleeve. Oil is fed under pressure to the surface of each pin through radial holes in the muff part which communicate with the central oil hole of the turbine shaft and receive oil from the adjacent bearing. It will be particularly noted that there is no loose shell, as in many types of coupling, which when worn in the jaws moves radially and causes trouble by throwing the turbine out of balance. Nothing of this kind can occur in the design shown, and the worst that happens is hammer pitting of the pins and wear of the holes, which are not sufficiently significant displacements of mass to upset the balance. Such wear has its remedy in re-boring and fitting new pins. It permits of the freest possible axial motion, and will take up the minute want of alignment, which is all that is permissible with any type of turbine coupling.

Figs. 25 and 26, annexed, show sections through the type of low-pressure shaft gland usually employed by Messrs. Belliss and Morcom. It contains, as will be seen, three pairs of carbon rings, each pair held separately in its own housing. Light garter springs, having their ends attached to small plates screwed to the joints of the housings, keep the rings up to their work. The rings are, of course, in segments with "broken" joints. They run on a hard steel bush held on the shaft by a nut, and are steam-packed in the ordinary way. The nut serves as a thrower for any moisture which may escape from the gland, the droplets being flung off into the grooves of the end cover of the packing-box and conducted away to the drains. The design of the gland is such that each half is self-contained in the corresponding part of the casing, so that the glands are not disturbed when the casing is opened and the rotor lifted. In large turbines where the front pedestal is detached from the casing so as not to conduct heat therefrom, the H.P. gland is necessarily of the labyrinth type. Where permissible, however, the compound type as shown in Fig. 4, Plate XLIII, published last week is preferred.

The feature of the main bearings of the turbine is a broad gun-metal safety strip at the centre of each bearing, which is large enough to support the shaft safely in the very unlikely event of the white metal running out. The position of the strip renders it highly improbable for the oil hole to be clogged by the white metal in case of such an accident, and provided the oil supply does not fail, the turbine can run on the safety strip for a short time without damage. Messrs. Belliss and Morcom have indeed a record of a case when the turbine had evidently been running on the safety strip for several hours, the state of affairs only becoming known by an investigation into the cause of the high temperature at which the bearing was running. The steps of the bearings are spherical to permit of self-alignment of the rotor shaft. The high-pressure bearing is used to locate the turbine rotor axially. The steel collar which runs against the inner end of the bearing also bears against a "Michell" thrust-ring adjustably bolted to the casing. This is where the axial thrust of the turbine is taken up. The bearing is shown in Fig. 23, page 803.

The Michell thrust bearing consists of rubbing pads cut away at the back so that the support of each lies just behind the centre of gravity of the rubbing face. As the shaft rotates oil is dragged in between the thrust collar and the faces of the pads, and the way the latter are supported causes each to tip a little so that the continual entrance of fresh oil is facilitated. Thrust blocks on the Michell principle can be loaded to at least 10 times the pressure per square inch which is permissible on a plain thrust bearing, and as the residual thrust on an impulse turbine is very small, the single Michell ring affords a large margin of security. With the exception of their first four machines, and a few incidental ones, the whole of the turbines built by Messrs. Belliss and Morcom have been fitted with Michell thrusts. This firm were the first to adopt the Michell bearing for steam turbines, their confidence in the type being largely based on the results of the experimental work carried out by Mr. W. T. Newbigin at their factory. The plain collar is screwed on to the shaft and is easily removable, the block itself is also readily removed after slipping out the main bearing. In some of the earlier machines the block was fitted at the end of the shaft, but in order not to interfere with the accessibility of the governor mechanism, and particularly to minimise the relative longitudinal movement of the rotor and the casing due to expansion, the block is now fitted at the inner end of the bearing.

Fig. 29, on page 805, shows diagrammatically the oil connections of a large turbine. These are of necessity somewhat elaborate, for not only has forced lubrication to be supplied to all bearings, but oil under pressure is also used to operate the relays for governing and emergency stopping. The oil, moreover, has to be continuously cooled and strained. The main oil reservoir is in the turbine bed. Passing first through a strainer it flows normally to a submerged oil pump of the gear type, driven as already seen from the lower end of the governor spindle. From the pump it flows first to the oil coolers, and thence in parallel to all bearings and to the relay cylinders. Every bearing has its own pressure gauge. A failure of the oil pressure results automatically in the prompt shutting off of the steam, as the emergency stop valve can only be maintained open by the action of the oil pressure. To start up the turbine, it is necessary to produce an oil pressure first, not only to ensure the bearings being flooded but to operate the emergency valve. This is done by the small independent direct-acting steam pump shown in the diagram, which takes oil from the strainer and forces it through the cooler to the required places in the same way as the main pump does.

Smaller turbines are provided with a hand pump, instead of a steam pump for this purpose, which is quite adequate in such cases. The oil pressure adopted by Messrs. Belliss and Morcom, Limited, is from 30 lb. to 40 lb. per square inch, which is high enough to do away with the uncertainties and complications involved when, as in the case of many turbines, a much lower pressure is used. The reason why a lower pressure is more general is that it has been found troublesome to keep the oil from weeping at the pedestal glands when the ordinary ring and groove design is adopted. The high-pressure system however, does away with the necessity of having an automatic cut-in for the auxiliary oil pump and the need of operating this pump when shutting down, and an effective pressure is given by the main oil pump practically to the point of stopping, and there is never any uncertainty as to whether the bearings are getting an adequate supply of oil. In the unlikely event of the bursting of an oil pipe or a breakdown of the main oil pump, it is not likely that the situation will be saved by the automatic starting up of an auxiliary oil pump, and it is far safer that the machine should shut itself down.

Figs. 30 to 34 show the cooling arrangements as supplied for the 10,000-kw. Belliss and Morcom turbine at West Ham. There are two coolers, each having 264 sq. ft. of surface. Each is something like a two-pass vertical condenser in construction. The oil passes through the tubes, and the water circulates around them. Expansion of the tubes due to the heat of the oil is provided for by suspending the whole set of tubes from the upper tube plate, so that they are unrestricted as regards any expansion they may undergo. A very complete arrangement of valves is provided for controlling the oil and water circulation through the coolers. Either cooler may be worked by itself and the other opened up for cleaning or inspection, or both may be used simultaneously.

Similar oil-cooling plant has been supplied to

Fig. 25.

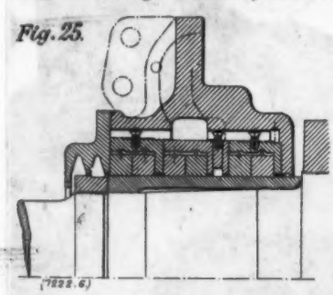


Fig. 26.

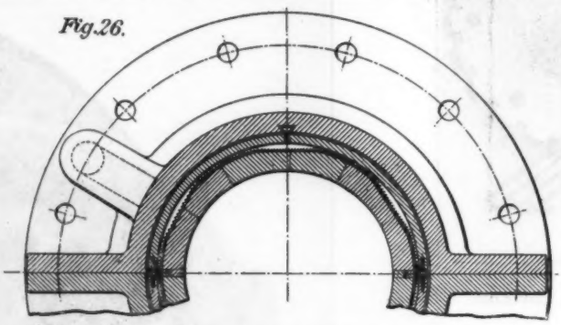


Fig. 27.

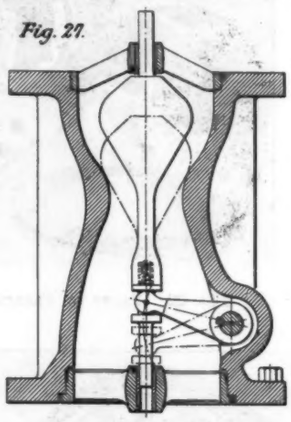
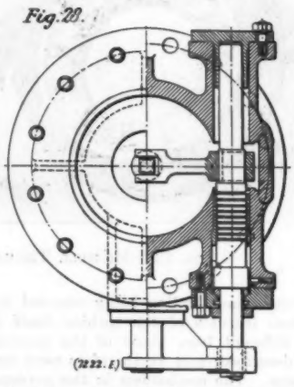


Fig. 28.



LUBRICATION SYSTEM AND OIL COOLERS FOR STEAM TURBINES.

CONSTRUCTED BY MESSRS. BELLISS AND MORCOM, LIMITED, ENGINEERS, BIRMINGHAM.

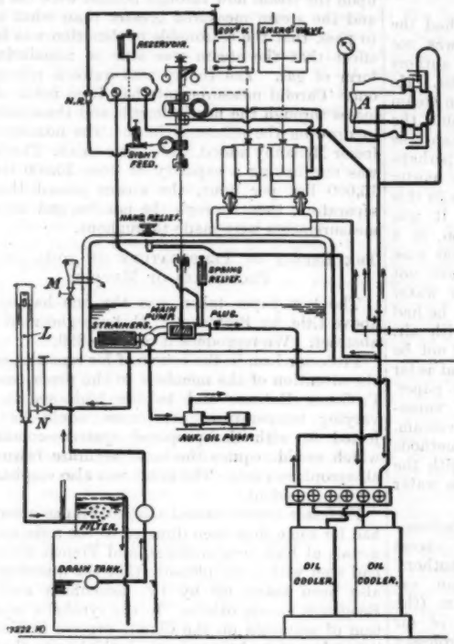


Fig. 29

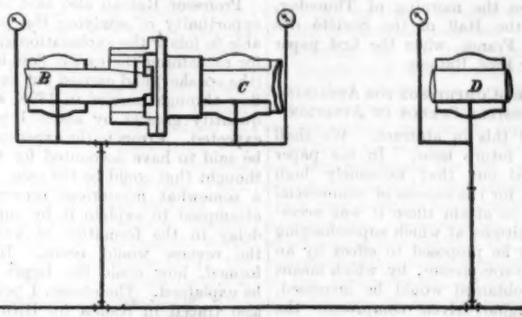


Fig. 30.

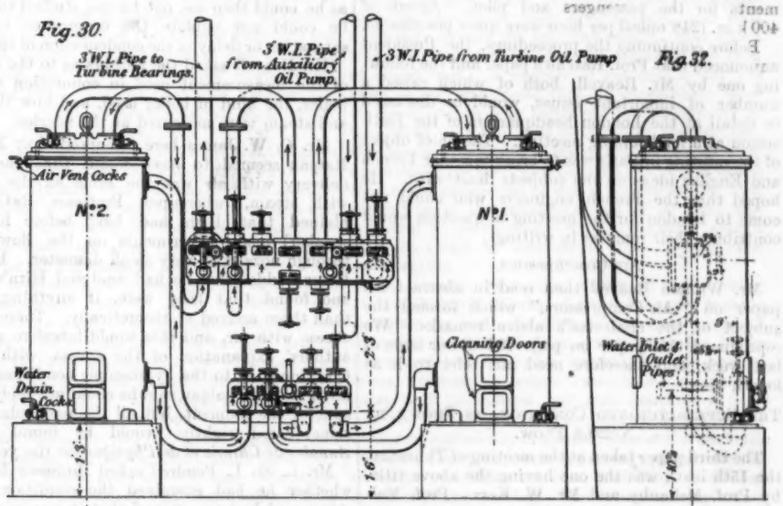

3 W.I. Pipe to Turbine Bearings.
3 W.I. Pipe from Auxiliary Oil Pump.
3 W.I. Pipe from Turbine Oil Pump
Air Vent Cocks
No 2.
No 1.
Water Drain Cocks
Cleaning Doors
Water Inlet & Outlet Pipes
Water Outlet
Water Inlet
Brass Cased Thermometers 3 in. each Box.

Fig. 32.

Fig. 31.

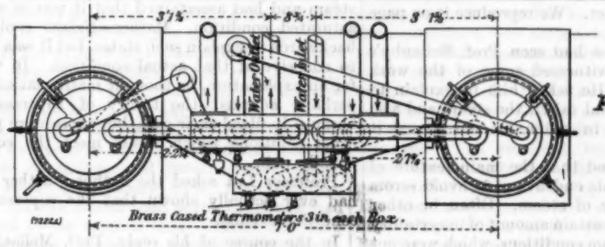


Fig. 33.

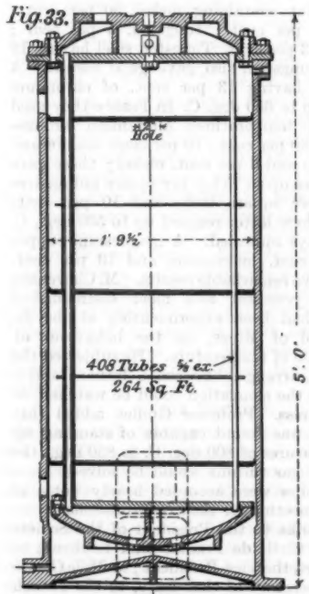


Fig. 35.

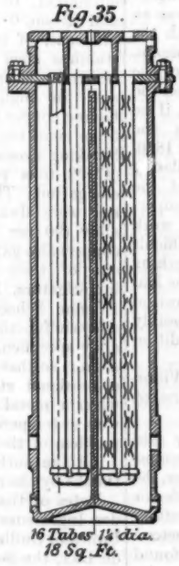


Fig. 34.

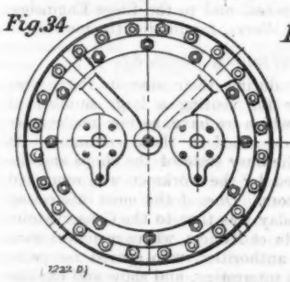


Fig. 36.

5,000-kw. and 3,000-kw. sets, although in some cases the type of cooler is different. Other cases have motor-driven auxiliary pumps, such variations being incidental. Another type of cooler, and one which is much preferred by Messrs. Belliss and Morcom themselves, is that illustrated in Figs. 35 and 36. Here the battery consists of copper "Row" indented tubes. This cooler is very much more efficient for a given surface than the straight tube type, on the whole it is far less troublesome to clean, and it is more robust. The oil is, of course, inside the tubes, and the experience for many years is that choking from sludgy oil is practically impossible, at any rate it seems never to have happened.

In connection with the lubricating arrangements, attention should be drawn to a sight feed lubricator, shown in Fig. 29, which supplies oil to the inside of the governor valve. In spite of the current idea that a turbine requires no internal lubrication, it has been found by Messrs. Belliss and Morcom that the feeding in of a minute quantity of oil along with the steam has a great protecting influence on the blades and the internal steel surfaces generally. The most vulnerable period for a steam turbine is when it is standing idle for a day or two, and some makers have provided turbines which were particularly susceptible to corrosion with a paraffin-flushing apparatus, by which a dose of paraffin could be injected just before stopping the machine. The protective influence of a minute film of oil on the internal parts of a turbine is indicated by the fact that mixed-pressure and low-pressure turbines, which work with the exhaust steam from internally-lubricated reciprocating engines, are not liable to suffer from corrosion. The casual application of paraffin to the interior of turbines is not considered an adequate safeguard against corrosion, and Messrs. Belliss and Morcom therefore fit, in all cases where it seems desirable, a proper sight feed lubricating arrangement set to deliver oil to the inside of the turbine at the rate of about one drop per minute. The quantity is so small, and the action of a turbine as an oil-separator is so efficient that no trouble with greasy feed-water is experienced.

In conclusion we desire to acknowledge our obligation to Messrs. Belliss and Morcom, Limited, for kindly permitting us to make a full inspection of their turbine work at Birmingham for the purposes of this article.

THE INSTITUTION OF MECHANICAL ENGINEERS.

(*Concluded from Page* 778.)

MEMBERS of the Institution of Mechanical Engineers reassembled, on the occasion of the summer meeting in Paris, on the morning of Thursday, the 15th inst., in the Hall of the Société des Ingénieurs Civils de France, when the first paper taken was the one by Prof. Rateau.

THE USE OF THE TURBO-COMPRESSOR FOR ATTAINING THE GREATEST POSSIBLE SPEEDS IN AVIATION.

Prof. Rateau read this in abstract. We shall reproduce this in a future issue. In his paper Prof. Rateau pointed out that extremely high speeds were requisite for the success of commercial aviation. In order to attain these it was necessary to fly at high altitudes at which supercharging was essential. This he proposed to effect by an exhaust driven turbo-compressor, by which means the effect in work obtained would be increased, whereas with an engine driven compressor the available power for propulsion was reduced. Steps would have to be taken to make efficient arrangements for the passengers and pilot. Speeds of 400 k.m. (248 miles) per hour were quite practicable.

Before continuing the proceedings, the President announced that Prof. Rateau's paper and the following one by Mr. Reavell, both of which raised a number of important issues, would be discussed in detail at the London headquarters of the Institution at a forthcoming meeting. The chief object of the meeting in Paris was to bring together French and English ideas on the subjects dealt with. He hoped that the French engineers who could not come to London for the meeting in question would contribute their remarks in writing.

AIR-COMPRESSORS.

Mr. William Reavell then read in abstract his paper on "Air-Compressors," which formed the subject of the chairman's above remarks. We reproduced this paper on page 782 of our issue of last week, and therefore need not refer to it at length here.

THE SUPERSATURATED CONDITION, AS SHOWN BY NOZZLE FLOW.

The third paper taken at the meeting of Thursday, the 15th inst., was the one having the above title, by Prof. Mellanby and Mr. W. Kerr. Prof. Mellanby read it in abstract. We reproduce it on page 832.

The President said he had seen Prof. Mellanby's laboratory and had witnessed some of the work carried out therein. He asked him to explain to the meeting how he had raised the steam and also as to the conditions in which he had passed it through the nozzles.

Prof. Mellanby stated that the main feature of his experiments was his endeavour to avoid errors in regard to the flow of steam. Often in other work there had been a certain amount of uncertainty as to the matter of steam conditions, which were not all known. He passed the steam coming from a fairly large boiler through a separator and then through one or two small superheaters. These were at first gas-fired, but, owing to the coal strike at the time of his experiments, he turned to electric super-heaters, and continued using them. He found they had one advantage. At the outlet he got any temperature and pressure required. He then passed the steam through the nozzles. The researches were directed to finding the pressure drops, for on these depended the losses. He used search tubes, and was able to calculate the losses at any part of the nozzles. Knowing exactly the conditions of the steam in each experiment and what the actual flow was, he could arrive at his curves. He asked the members to notice the falling away at the beginning of these, this being partly accounted for by reversion to wetness. In turbine work the trials often did not come out as had been expected, and the only way to account for the discrepancies noticed was by assumption of the supersaturated condition. The experimental data in the paper would, he thought, be found important for reference in connection with steam turbine designing.

Prof. Sauvage stated that the authors' paper was of great scientific importance and value to the designers of steam turbines. It required careful study. He was unable just then to discuss it, but would be pleased to communicate his remarks in writing.

Professor Rateau also said he had not had the opportunity of studying the paper, and was not able to follow the explanation given by the authors for explaining the excess flow in the nozzles. He (the speaker) had carried out experiments in steam flow through nozzles in 1895, and had found the quantity greater by about 1 per cent. than was expected. Errors in the experiments might perhaps be said to have accounted for this, but he hardly thought that could be the case. There was in this a somewhat mysterious occurrence, and it was attempted to explain it by supersaturation, or a delay in the formation of water. In that case the reverse would occur. If water were not formed, how could the larger amount of water be explained. The excess, 1 per cent. also, he had also traced in results by Hirn dealing with air, and in this latter instance the excess could not be explained by supersaturation. Personally, and as far as he could then see, not having studied the paper, he could not explain the occurrence of supersaturation or delay in the condensation of the steam.

Mr. Reavell asked the authors as to the methods of the measurement used in connection with the boiler, the kind of boiler used, and how the water and steam were measured at the nozzles.

Mr. C. W. James here remarked that Professor Rateau seemed to have found that the excess delivery with air was the same as the authors' with steam, whereupon Professor Rateau explained that Hirn had long before him (the speaker) made experiments on the flow of air through nozzles of very small diameter. Professor Rateau added that he had analysed Hirn's figures and found that they were, if anything, higher than those arrived at theoretically. There was an excess with air, and this would interfere with the authors' explanation of the excess with steam. Questioned as to the hygroscopic conditions of the air, Professor Rateau said he could not reply on the spur of the moment, but all the particulars, if he remembered rightly, would be found in the *Annales de Chimie et de Physique* for the year 1886.

Mr. L. St. L. Pendred asked Professor Mellanby whether he had examined the condition of the steam and had ascertained that it was in a supersaturated condition. Mathematicians could work backwards to explain such states, but it was difficult to conceive of that actual condition. In working for an explanation, he thought mathematicians had perhaps adopted the theory of supersaturation because it fitted their case, but there were possibly other solutions which would meet the condition equally well.

Professor Lea asked the author whether Wilson had ever actually shown that the supersaturated condition existed.

In the course of his reply, Prof. Mellanby said it was difficult to give verbally a complete account of the work carried out. It might, however, be said to have arisen to a great extent from Professor Rateau's own experiments which had been carefully made. The steam passing through nozzles instead of being what had been expected was often found to be much greater than the amount arrived at by theory. This had led to a series of experiments. It was really following upon Professor Rateau's work on steam flow that the question of supersaturation came up. He (Professor Mellanby) had never come across air experiments which really gave similar results when analysed. Air was difficult to measure; with air one could not get sufficiently definite data to enable one to say that supersaturation was present or not. He had tried with air and had not found any excess of discharge. In reply to Mr. Pendred, if the supersaturation could be measured the difficulty would easily be solved, but the question had to be attacked indirectly. There was supersaturation. It could be shown by experiments to exist. How it was possible to get supersaturation in the nozzle he partly explained by the fact that the steam had no time to condense. The time element thus came in, while if all particles of air were removed from steam it could not condense unless it had particles to condense upon. In the short time it took to pass the nozzle it was safe to say that the steam could not condense. It was fair to argue if repeated results upon the steam flow through nozzles were the same, and the steam measured greater than what ought to pass, that the reasonable explanation was to the effect that the steam was able to remain in the form of gas. The theory was quite a reasonable one. Careful measurements had been made of the losses through the nozzle length, and these came in in drawing the efficiency lines. The nozzles, Professor Mellanby added, were quite small. The boiler was one having a capacity of from 10,000 lbs. to 15,000 lbs. per hour, the steam passed through separators, then through the nozzles, and accurate measurements were made throughout.

THE EFFECT OF TEMPERATURE ON SOME OF THE PROPERTIES OF METALS.

The last paper taken was the one having the above title, by Professor F. C. Lea, who read it in abstract. We reproduce it on page 829.

Professor Lea, in the course of his remarks, called the attention of the members to the paper read by Professor Rateau, and to the high speeds and varying temperatures aeroplanes would be subjected to with the proposed system—conditions which would require the most accurate testing of all aeroplane parts. The point was also emphasised by the President.

Professor Guillet stated that in France attention had for some time been directed to the resistance of metals at high temperatures, and French scientists had seen with great pleasure that the question had also been taken up by Dr. Rosenhain and Dr. Bengough among others. In the synthetic production of ammonia on the Claude process in France, it had been found that the steel which gave the best results was that containing nickel, 50 per cent.; chromium, 10 per cent.; tungsten, 3 per cent.; and carbon, 0·3 per cent. Tungsten steel having 18 per cent. of tungsten, also gave good results. A stainless steel having 13 per cent. of chromium resisted well up to 650 deg. C. In France they used also for high temperatures aluminium bronzes having copper 80 per cent., 10 per cent. aluminium, 5 per cent. iron and 5 per cent. nickel; these gave breaking stresses up to 75 kg. per square millimetres (47·62 tons per square inch) and 10 per cent. elongation. These latter resisted up to 500 deg., C. and were always annealed. A magnesium copper alloy (90 per cent. magnesium and 10 per cent. copper) also gave remarkable results. M. Chevenard one of their youngest and most distinguished investigators, had been experimenting at the St. Etienne School of Mines, on the behaviour of alloys in function of temperature. He subjected the alloy specimen, arranged between a furnace and a mirror, so that the elongation could be watched, to a tensional stress. Professor Guillet added that when a metal was found capable of standing up well to temperatures of 800 deg. C. to 850 deg., the problem of the gas turbine would be solved.

All the authors were accorded hearty votes of thanks by the meeting for their contributions.

Votes of thanks to the President of the Société des Ingénieurs Civils de France, Max Laubeuf; to Professor Guillet, the Vice-President; to M. le Comte de Dax, the Secretary of that body, to the French establishments visited, and to the Liége Engineers, Municipality and Works, terminated the meeting.

EXCURSIONS, VISITS, &C.

The members during their stay in Paris were granted facilities for visiting a large number of works, many of which we have, as our readers are aware, recently described in these columns. At all these works the busy state of the shops and the industry displayed by the workmen was remarked upon by the visitors. One of the most interesting visits on Wednesday was that to the Conservatoire National des Arts et Métiers, where members were received by the authorities, who spared no pains to make the visit interesting, and show and explain anything which particularly attracted attention. In several cases special facilities were granted for the inspection of original apparatus of historic interest. Similar attention was very kindly paid

to visitors to the Laboratoire d'Essais, where all the departments were open to inspection under guidance of the heads of the technical staff. On Thursday other visits were paid to works in the afternoon, and also to the Eiffel Tower wireless telegraphic station.

On Thursday evening a very successful dinner took place at the Continental Hotel, at which the guests included M. Max Laubeuf, Professor Léon Guillet, M. Eiffel, Professor Rateau, Mr. H. G. Mackie, C.B.E., His Majesty's Consul-General, Mr. John Laurier, president of the British Chamber of Commerce of Paris, and others. The occasion was naturally one for reviewing what French and British engineers and scientists had done together during the war, and independently through the whole development of engineering from the early days. The technical and commercial interests of France and Britain were dealt with in a speech by Mr. W. Reavell, to which Professor Léon Guillet replied in a very interesting speech in French which embraced engineering, physics and chemistry, and covered a very wide range of time and subject. M. Max Laubeuf replied for the guests in a short but very pleasant speech in English, in response to the toast given by the President, who we may say acted as his own interpreter with very happy effect.

On Friday, as is usual at these meetings, various excursions were arranged, one of the most pleasant being to Fontainebleau. In the evening members were the guests at an excellently managed soirée, given by the Association Amicale des Anciens Elèves de l'Ecole Centrale des Arts et Manufactures.

Ceremony at the Arc de Triomphe.

In view of the events which have occurred since the last Paris meeting, which was held a few days before the outbreak of war in 1914, the present meeting was fittingly brought to a close on Saturday morning with a ceremony which was arranged to take place before members left for Liège. At 10 a.m. members and ladies assembled on the Champs Elysées and formed a procession which marched to the Arc de Triomphe and there laid on the grave of France's Unknown Warrior a large wreath as a token of regard from the Institution of the great effort France had made during the war, and recognition of the common sacrifices made by the two countries and shared by the Institution.

A few suitable remarks were made by the President, Dr. Hele-Shaw, after the wreath had been laid on the grave, and the tribute was officially acknowledged on behalf of the French Ministry of War by Colonel Bertin, Etat Major de l'Armée Française, in a very sympathetic and touching speech in French, in which he spoke of the equality of all men of both countries in the great struggle, and of the effect of the sacrifices which had been made, expressing the hope that the future would only strengthen the ties thus formed between the two countries.

Liége Meeting.

[Members of the Institution, to the number of about 100, left Paris for Liége, Belgium, at mid-day on Saturday, the 17th inst., to be present at the Congress in the latter city, which was being held to commemorate the seventy-fifth anniversary of the formation of the Liége Association of Engineers. The history of this association is very briefly as follows: In the year 1847, ten former engineering students of the Liége University met together and decided to constitute an association; very shortly afterwards 54 others joined with these, and the association had its origin in these 64 members. Since then it has largely extended its scope, and numbers at the present time 2,300 members, among whom are mining, mechanical and civil engineers, metallurgists, chemists and scientists distributed throughout the world. The association commenced issuing Proceedings in 1849; these, in the year 1877, were incorporated with the *Revue Universelle des Mines*, and the latter, a well-known fortnightly journal, has since been the record in which the association issues the accounts of the researches and work carried out by its members. The review itself was founded by former eminent professors of Liége University, among whom we may mention Ch. de Cuyper, J. P. Chandelon, L. Trasenster, L. de Koninck. The present president of the Scientific Committee of the Association, is Mr. H. V. Hubert, C.B.E., General Inspector of Mines and Emeritus Professor of Applied Mechanics and Industrial Physics of the University.

The proceedings at Liége opened on Sunday morning, the 18th inst., when His Majesty the King of the Belgians unveiled at the university a memorial to 214 former students who fell during the war. A similar ceremony took place in the building of the association, where a memorial to 28 former Belgian members, victims of the war, was also unveiled. In the afternoon, the King opened at the Palais des Beaux-Arts the exhibition which has been organised by the association. The exhibition is to remain open until July 31. The King was received by Mr. G. Trasenster, president of the association, who recalled the history of the latter, the progress achieved since its inception, and the debt which science and industry owed to such eminent professors as L. Trasenster, Despret, Gillon, Habets, Deschamps, to a number of no less eminent works owners, and to men like Montefiore-Levy, the generous founder of the Liége Electro-Technical Institute. In the course of his speech, the King said he was very happy to see that the congress had instituted a Colonial Section. He could not overemphasise the desirability for Belgian engineers of exerting every effort in the direction of exploring and turning to account of the natural wealth of the Congo. A colony was the domain *par excellence* in which the activity of an engineer should exert itself to the full. Nothing that was durable, the King added, could be accomplished in a colony without the aid of technical men.

On Monday morning, the 19th inst., the Congress was formally opened at the Palais des Beaux-Arts by Professor Hubert, who, on behalf of the association, extended a cordial welcome to all visitors and thanked the Institution of Mechanical Engineers—who also was celebrating its seventy-fifth anniversary—for having called at Liége on the way back to London from the Paris meetings. He recalled the former congresses, held in Paris in 1878, 1889 and 1900, on the occasion of the exhibitions of those same years; those held in Liége in 1905 and in Düsseldorf in 1910, adding that the hope had been expressed of holding one in 1915 in London, and one in Vienna in 1920. This hope, unfortunately, had not materialised owing to the war, a war declared by Germany, during which Belgian and French industries had been systematically destroyed. Numbers of most eminent German scientists, Professor Hubert recalled, had endeavoured since either to deny or to excuse the acts of their officers and men, the ruthless manner in which they had carried out the work of annihilation and the means employed therefor, conduct which was formerly attributable to the lowest and most primitive races alone. Germany was taking no part in the Congress; she was still far from having reassured the world in regard to the correct and only possible conception of justice and international equity. Dealing more particularly with the Congress, Professor Hubert stated that several sections had been added to the original ones. There were now eight, covering geology, mining, metallurgy, mechanics, electricity, chemical industries, civil engineering, and a colonial section. The papers to be read numbered some 200, a fact which afforded a proof of the importance which the industrial and scientific world attached to the Congress. Professor Hubert then announced the hours and places of meeting. Each section held four meetings; on Monday afternoon, the 19th inst., on Tuesday morning and afternoon, the 20th inst., and on Wednesday morning, the 21st inst. The section covering Mechanics was sub-divided into three groups, as also was that dealing with Electricity.

At one of the meetings of the Metallurgical Section, Professor Guillet, who occupied the chair on the invitation of the acting-president, Mr. Octave Hock, paid a graceful compliment to the memory of the late Mr. Adolphe Greiner, director of the Cockerill Works. The occasion was the reading of two papers, by Mr. J. Dupuis, of the Usines St. Jacques, Montluçon, France, on "The Utilisation of Coke-Oven Gas in Open-Hearth Furnaces," and by Mr. R. Bourgy, of the Cockerill Works, on "The Various Fuels, principally Coke Oven-Gas and Tar, used in Open-Hearth Furnaces." Prof. Guillet recalled that Mr. Greiner, in the course of his presidential address delivered in May, 1914, before the Iron and Steel Institute, had dealt with the use of coke-oven gas and also tar in metallurgical processes. A proof of Mr. Greiner's indomitable energy in most adverse and discouraging circumstances was afforded by the paper on "The Heating of an Open-Hearth Furnace by means of Tar," which he managed to send to the May meeting of 1915 of the same institute.

Reverting to the two above-named papers, Mr. Dupuis said that in considering improvements in the fuel problem as it affected metallurgical works, substitutes for coal were looked for with a view to heating open-hearth furnaces. Apart from liquid fuel—tar and mineral oil—coke-oven gas was the only substitute the use of which had been attended with good results, since it was the only one which gave a higher temperature than that of coal-producer gas. Coke-oven gas, however, should not be allowed to flow through the regenerators in its pure state, owing to the dissociation which occurred of the hydrocarbons, giving rise, among other consequences, to the deposition of carbon. The dissociation, if it were not for the carbon deposition, would be attended by no disadvantage from the purely calorific point of view, since the corresponding reactions were endothermic, and took from the checkers the required sensible heat which was found again in the furnace hearth in the form of latent heat. A mixture of gas and steam was tried and it was found that an exceedingly large excess of steam was required, one absolutely inconsistent with the good working of the furnace. On the other hand, by using a mixture of producer gas with 20 per cent. of coke-oven gas, it was found that a low proportion of steam corresponding with saturation in the neighbourhood of 50 deg., was sufficient to prevent carbon precipitation; such a mixture could be allowed to flow through the regenerators.

Mr. Bourgy gave the history of the working at the Cockerill Works of an openhearth furnace using tar as fuel. In 1916, this furnace produced every grade of steel, from extra mild for boiler furnace-plates, to extra hard steel for special tyres, starting in every case from low-quality scrap and phosphoric pig-iron, containing from 1·4 to 1·7 of phosphorus. The final additions consisted exclusively of spiegel made at the Cockerill Works. The phosphoric pig-iron required the use of large quantities of lime, and this somewhat lengthened the working. The total consumption of tar per ton of steel, 160 kg. (352 lb.), was in the circumstances a very satisfactory one. During the war, the works manufactured over 20,000 tons of steel, using tar exclusively as fuel, to an amount of 3,250 tons. In 1920, the starting of 30 coke ovens rendered available a certain amount of rich gas which was utilised in the tar-fired open-hearth furnaces. The atomised tar jet was found to lower satisfactorily the coke-oven gas flame and prevented this from rising up to the furnace roof. The tar, moreover, yielded a perfectly luminous flame which facilitated the working of the furnace. By this means, over 50 per cent. of tar has been replaced by the gas, and the time element remains practically as it was when using tar alone. In one case, 410 heats were made, and the furnace had to be laid idle, by reason only of the melting of a door frame; the roof itself could easily have stood 50 more heats. The tar consumption was 75·5 kg. (165 lb.), and the gas consumption 194 cub. m. (6,850 cub. ft.) per ton. The calorific value of the gas was 3,600 calories (404 B.Th.U.).

An interesting paper by Professor Guillet had for its title "Light Alloys and Recent Progress in their Manufacture and Use." This dealt specially with the aluminium-silicon alloy "alpax," which cast and suitably refined with alkaline salts had a tensile strength of 18 kg. to 23 kg. per square millimetre (11·4 tons to 14·6 tons per square inch), with an elongation of from 5 per cent. to 10 per cent. The paper also dealt with duralumin and referred to the work by Rosenhain, Archbutt and Hanson on this alloy. "Pure magnesium was not an interesting metal, notwithstanding its low specific gravity (1·8), but its alloys with zinc (1 per cent. to 5 per cent.) and aluminium (0·5 per cent. to 5 per cent.) had a tensile strength of 27 kg. per square millimetre (17·1 tons per square inch),

an elastic limit of 15 kg. (9·5 tons per square inch), and an elongation of 15 per cent. Great progress had also been made in regard to the magnesium-copper alloys containing 8 per cent. to 10 per cent. of copper, and to the aluminium-copper alloys for the manufacture of a number of mechanical parts." He then drew the diagrams of different binary alloys, and pointed out that those of magnesium and cadmium were practically the only ones having important solid solutions.

Another communication by Professor Guillet reviewed the "Recent Progress in Micrography and Macrography," and gave the history of both, in the matter of polishing the specimens, their etching and their examination, and photography. In regard to polishing, no automatic machine for doing the work had as yet given satisfaction. As a novelty in the matter of etching, the author mentioned oxygenated water in sodic solution (Yatsevitch) picrate of sodium (Comstock); electrolytic etching, notable for examining copper and its alloys, with a solution of citric acid or of ammonium molybdate (Adam). For the examination of the etched specimens the Le Chatelier apparatus was more in use than ever; the support of the apparatus had now three columns instead of one, this rendering the platform more stable. The author then reviewed the various lenses and illumination methods, and indicated the desiderata under the three headings, polishing, etching and photography. In regard to macrography, this should be resorted to in every works, especially perhaps in the shops in which common metallurgical products are either manufactured or utilised.

A paper by Mr. J. Seigle, professor at the Nancy School of Mines, dealt with the inspection of iron castings, and stated that the structure, plus the indication of the phosphorus content sufficed to characterise the castings, without having recourse to the usual tensile, bending and shock tests. These tests, made on specimens which did not as a rule cool down as did the castings themselves, generally afforded no criterion. This view did not meet with the approval of Professor Guillet, who advocated the ball test, a much more scientific method of inspecting castings than the mere examination of the structure alone. During the war an enormous quantity of semi-steel castings had been made in France, all of which had been passed by ball tests. Mr. Octave Hock added that if the use of a small ball impression did not sufficiently characterise a casting, a larger one could be used acting on a larger area. Mr. Chevenard, chief of the Research Department at the Imphy Steel Works, also deprecated the passing of castings by the structure alone.

The papers read in abstract before the Metallurgical Section numbered 29, the majority of which do not lend themselves to a brief abstract; 43 were announced to be read before the Mechanics Section, and as many again before the Electricity Section. The programme of the other sections was comparatively less heavy, but all sections were well attended, and the papers read gave rise to remarks and to thanks to the authors rather than to a general discussion; this latter, it was announced would be mainly by correspondence in the Proceedings of the association. Unfortunately, copies or abstracts of the papers, except as regards the Metallurgical Section, were not available in advance.

The works in Liége and the vicinity were open to the visitors, a large number of whom availed themselves of the facilities thus afforded them of witnessing the activities being displayed at the present time by Belgian firms engaged in mining, metallurgy and engineering in all its branches. A visit was also paid to Loncin Fort, overlooking Liége, a fort which in the early days of the war succumbed after a heroic resistance against overwhelming odds, in numbers, of the enemy's armies.

The exhibition above referred to is contained in the two wings of the Palais des Beaux-Arts and in two small buildings on each side of and symmetrically to these. A few exhibits are also distributed in the adjoining grounds. The display consists of rolls; sections; steel plates, one measuring 10 m. by 3 m. by 20 mm. (32 ft. 10 in. by 9 ft. 10 in. by ¾ in.); steel sheets; rails and sleepers; ladles; drawings, plans, diagrams and photographs—all of which illustrate the character and the extent of the work being carried out by our Belgian friends.

THE INSTITUTION OF GAS ENGINEERS.

(*Concluded from page* 790.)

THE first business dealt with when the meeting was resumed on Wednesday morning the 21st inst., was the reading and confirmation of the minutes of the last annual general meeting of the Benevolent Fund. The annual report of the Committee of Management of this fund for the year 1921–22, and the accounts for the year ended December 31 last, were also read and adopted.

GAS BURNERS.

Dr. Charles Carpenter was then asked by the Chairman to read his paper entitled "Some Gas Burners and a Moral," which formed the next item on the agenda. In this Dr. Carpenter gave a brief history of the development of gas burners, and pointed out that practically the whole of the invention and research work necessary to bring about this development had been carried out in independent workshops and laboratories. He also pointed out that no matters essential to the gas consumer of to-day were the subjects of patents, and added that one effect of this was that much of the production and marketing of these essentials to the gas industry had passed into the hands of "shoddy" manufacturers and unscrupulous agents. In an appendix to the paper some very striking comparisons were made of the results obtained with such burners and those given by the "Metro" burners designed and made by the South Metropolitan Gas Company. It would be well, he said, if the gas engineers looked more carefully into the smaller matters, such as gas-burner construction and the suitability of gas appliances for consumers' use, since these were of vital importance to the success of the business. The South Metropolitan Gas Company had now been considering the question for over 14 years, and, as a result of their experience, had concluded that burners in which the proportion of gas and air was fixed should be provided for consumers of the company's gas. It was realised, however, that, for a system of this kind to be successful, it was necessary to provide not only standard burners, but also to supply a gas of uniform quality. The moral referred to in the title of the paper was to be drawn from two diagrams exhibited, which showed the load lines of two undertakings supplying gas to a large city for periods about 30 years ago and recently. In one case the lighting load had increased and in the other it had fallen off.

A lengthy discussion, in which a considerable number of speakers took part, then followed, and some difference of opinion was noticeable as to the relative value of the lighting and heating loads. All of the speakers were in complete agreement as to the importance of supplying good burners and fittings, but several admitted that electricity had many advantages for lighting. In his reply Dr. Carpenter expressed appreciation of the reception given to his paper, and remarked that it was good for both industries that gas and electricity should be in competition. Except for a brief period during the war, when conditions were abnormal, he said, appliances having burners with fixed air and gas proportions had operated with complete satisfaction for the last 14 years. It was, however, important to keep all branches of the industry up to a high standard, and he would be well repaid if anything he had said helped in that direction.

INCREASING THE RATE OF CARBONISATION.

The Chairman then called upon Dr. G. Weyman to give his paper which bore the above title. In this paper Dr. Weyman first pointed out that the rate at which coal is carbonised is fundamental to the economics of gas production, labour charges, maintenance charges and capital cost being reduced almost in proportion to an increase in rate. Experments carried out in a coal testing plant on a scale of one-thousandth of a ton and using a retort cast in nickel-chrome steel, were then described, the more important conclusions to be drawn from these experiments being summarised as follows:—An increase in the rate of carbonisation caused by alteration in the chemical and physical conditions, due, for example, to the use of a more suitable type or size of coal, is accompanied by an improvement in the calorific value of the gas and of the thermal and volume yields per ton. Very considerable increase in the rate of carbonisation may be obtained by selecting those coals which give up their gas above a certain minimum rate. Except in the case of oxidised coals, the calorific value of the gas, and consequently the thermal yields, are higher for an increased rate. When the increased rate of carbonisation is caused by an increase in carbonising temperature the results are complicated by the fact that the portion of the gas evolved on the outside of the plastic layer in the retort is subjected to increased degradation, and this effect opposes the tendency of the higher rate to give a gas of greater calorific value. Up to the end of a certain time, the calorific value of the higher temperature gas is less than that of the lower temperature gas, but, volume for volume, there is a slight balance in favour of the former. After a certain period, when the coal at a high temperature is nearly carbonised, the calorific value falls off very rapidly, while the coal at a low temperature is still producing gas of moderate quality. Increases in volume and thermal yields per ton follow an increase in rate due to a higher carbonising temperature, which increases are impossible to obtain at a lower temperature. Volume for volume the calorific value of the higher temperature gas falls off at a slightly greater rate than that of the lower-temperature gas, but a greater volume of gas is evolved in high-temperature carbonisation, thus making up for the deficiency.

After Dr. Weyman had fully explained his paper, which he did with the aid of a number of lantern slides, the chairman read a telegram it was proposed to send to H.M. the King expressing loyal congratulations on the safe return of H.R.H. the Prince of Wales from his tour in the East.

The first speaker in the discussion on Dr. Weyman's paper was Mr. T. Glover, who remarked that the condition of the coal greatly affected the rate of carbonisation, small and dusty coals being bad conductors of heat. The shape of the retort, he added, also affected the question. As a rough average rule, about 1 hour per hundredweight was required for the carbonisation of coal, but this was not quite true. He had found that while about 14 cwt. could be carbonised in 12 hours in a "D"-shaped retort, 21 cwt. could be carbonised in the same time in a rectangular chamber. The speaker also referred to the fact that in vertical retorts part of the carbonisation was effected by hot gases from the lower parts passing up through the incoming charge.

Dr. Lessing also referred to the fact that the rate of carbonisation varied with the size of the coal. He remarked that the explanation that the smaller coal had a lower conductivity did not appear to be correct, and put forward an alternative explanation of the process of carbonisation at some length. Dr. Parker suggested that the presence of moisture might affect the variations of temperature in the gas leaving the refort referred to in the paper, and asked for further particulars of the experimental methods used. He also inquired if any deterioration of the retort had been noticed as a result of the formation of nickel carbonyl. Mr. Townsend also spoke with reference to the effect of the shape of retorts. Mr. Rhead asked if by "oxidised coal" referred to in the paper the author meant weathered coals.

In his reply Dr. Weyman agreed that the shape of the vessel was very important, but explained that his object had been more to get the heat from the surface of the retort into the coal than to get the maximum quantity of heat into the whole charge. The same retort, however, was used in all the tests, so that the results were strictly comparable. In answer to Dr. Parker, he remarked that the coal used was very dry containing only about ½ per cent. of moisture, and added that no deterioration of the nickel chromium steel retort had been observed, except for the formation of a very small amount of scale at the hot end. On the matter of the effect of the rising gases in vertical retorts the speaker said that this was most noticeable with light cannel

coals and less so with heavy coals. He admitted that the reference to oxidised coals in the paper was rather ambiguous, and explained that the coal was taken from seams near the surface, but was not weathered in the sense that it was left out in the open.

At this point the meeting was adjourned until the afternoon, and on re-assembling the paper taken was one by Mr. W. B. Leech, the chief engineer at the Beckton station of the Gas Light and Coke Company, dealing with recent reconstruction work at that station.

Reconstruction Problems at Beckton.

Mr. Leech, who was requested by the chairman to confine his remarks to a brief *résumé* in order to enable those members who wished to do so to leave early, then read extracts from his paper, which he illustrated by means of lantern slides. The object of the paper was to give a general description of what had been done together with the reasons which had dictated the policy adopted rather than to enter into details of some part of the new work. The principal work carried out during the last three years had been the provision of a new unit of carbonising plant in No. 7 retort house capable of supplying 6,000,000 cu. ft. per day, the re-design of the producers (260 in all) in other retort houses, the provision of new coal and coke handling plant for the No. 7 retort house, extensions to the purifying plant, extensions to the oil-gas plant, the erection of new engineering and wagon building shops, and the provision of a new water supply and filtration plant. After careful consideration, it had been decided to employ horizontal retorts in the No. 7 house. The retorts used were of "D" section measuring 24 in. by 18 in. by 23 ft. long, and were capable of taking a charge of 20 cwt. It has now been decided to adopt the silica segmental retort as standard. The alterations to the producers took the form of increasing their depth from 8 ft. to 13 ft., and this had resulted in greatly improved working.

Many different types of stoking machines are in use at Beckton, but in the No. 7 retort house two Drake's combined projector-charging machines were installed. Experiences with the other types were included in the paper, and the methods of transporting, quenching and screening coke were also explained. For the extensions to the purifying plant, ferro-concrete was employed owing to the high cost of cast-iron boxes at the time the work was carried out, and, on account of shortage of ground space, an oxide storage floor was built over the boxes. A pneumatic system, designed by Messrs. Henry Simon, Limited, is employed for handling the oxide. The other work above-mentioned, although described in the paper, was not referred to by the author owing to lack of time.

The discussion which followed the reading of this paper consisted mainly of the request on the part of a considerable number of members for further information upon matters of detail, and this information was duly supplied by the author in his reply. After this the chairman announced that a congratulatory telegram had been received from the Italian Institution of Gas Engineers, and that it was proposed to despatch a suitable reply. The meeting then adjourned until the following morning.

The first business for the meeting of Thursday the 22nd inst., was the formal welcome to the President and delegates of the Société Technique de l'Industrié du Gaz en France.

A Recording and Integrating Gas Calorimeter.

The paper bearing the above title, which was afterwards read by Professor C. V. Boys, F.R.S., gave a detailed description of the instrument designed by him to meet the requirements of the Gas Regulation Act, but it is only possible for us here to refer briefly to a few of the main points of the design. The instrument is of the usual water flow type, and both water and gas are passed through it positively at the correct rate, the correction for gas volume, as affected by temperature, pressure and contained water vapour, being also effected by a positive operation. The gas flow is kept at a definite rate of ¼ cu. ft. per hour, and the quantity of water passing is arranged so that its temperature will be raised 10 deg. C. by the combustion of the gas if the latter is of the declared calorific value. The water is measured out by a tilting box, and the waste water, which passes when the box is tilted, runs over a small overshot water wheel which supplies the motive power to drive the escapement of a clock. It also drives the gas-measuring device through an ingenious continuously variable gear which controls the speed of operation according to the value of the gas volume at the time. The gas-measuring device, which is somewhat similar to a wet meter, is in the form of a rotating drum constructed of celluloid, and arranged so that the greater part of its weight is supported by water. The quantity of gas passed, however, is independent of the water level. The heat of combustion is transferred to the water in a heat interchanger constructed of thin sheet lead in order to resist the acid products of combustion, and the two thermometers, by which the increase in temperature of the water is measured, are composed of brass tubes filled with amyl alcohol and closed at one end by means of thin corrugated metal lids. The thermometers are completely immersed in the hot or cold water, and the expansion of the alcohol, which produces a movement of the corrugated lids, operates the integrating and recording mechanism through a system of magnifying levers. Heat insulation is effected by surrounding the hot water compartment by a jacket of almost exactly the same temperature as itself, a small part at the lower end having a jacket at a rather higher temperature. There is thus hardly any radiation, or other loss of heat, from the hot water compartment, and there is a gain in the lower portion equal in amount to the very small loss. The object of the integrating device fitted in addition to the recording pen, is to show the extent to which the calorific value of the whole quantity of gas passed in a given period has been greater or less than the declared value. Finally, it should be mentioned that the water used in the instrument is stored in two tanks holding about 10 gallons each, and is continuously circulated by a pump driven by a small hot-air engine, so that any objection to water constantly running to waste is avoided.

A brief discussion followed the reading of Professor Boys' paper, and the questions raised were duly answered by the author. The next matter for consideration was the place of next year's meeting, and Sir W. F. Coates, the Lord Mayor of Belfast, proposed that that city should be selected. On behalf of the meeting, the chairman accepted this invitation with the reservation that it should be renewed at a later date nearer to the actual time of the meeting. After a number of votes of thanks had been proposed, seconded and carried, the formal business was concluded. The other items on the programme included a luncheon at the Savoy Hotel on Thursday in honour of the Société Technique de l'Industrie du Gaz en France, a reception and dance given by the President and Mrs. Hardie on Thursday evening at the Royal Institute of Painters in Water Colours, Piccadilly, and a visit to the Beckton Works of the Gas Light and Coke Company on Friday. The meetings were in all cases very well attended, and were regarded by all concerned as highly satisfactory from every point of view.

THE FOUNDRY TRADES EXHIBITION AT BIRMINGHAM.

(*Concluded from page* 782.)

The Constructional Engineering Company, Limited, of Charles Henry-street, Birmingham, exhibited a good variety of foundry plant, including a Wood's patent belted cupolette with drop-bottom and mounted on trunnions. This was equipped with hand-power hoist and electric blowing fan, forming a complete self-contained melting plant for an output up to 35 cwt. per hour. The firm also, exhibited an hydraulic pig-breaker, the pigs being broken under a small press operated by a pair of hand pumps. In the model foundry was shown the lower section of a large cupola, which was so arranged as to provide a hot air blast through the tuyeres. The air from the fan was forced to circulate round a belt several feet deep before it escaped through the tuyeres at the bottom. The cupola lining opposite the belt consisted of about 4 in. of carborundum bricks, which transmitted enough heat to raise the air to a high temperature and yet were both very durable, and sufficient to protect the ironwork of the belt. The belt, as will be gathered, was completely within the outer diameter of the cupola, and replaced part of the ordinary lining. Above the belt, the lining was of the usual material and thickness.

The Universal System of Machine Moulding and Machinery Company, Limited, of 97, Queen Victoria-street, London, E.C. 4, showed a large collection of moulding machinery of French manufacture, the chief feature of which is that ramming and other operations are done hydraulically. One of the most striking machines on the stand is the high-speed boxless machine illustrated in Fig. 19, page 810. With this machine, which was shown in operation a workman can turn out no less than 60 complete moulds per hour, measuring 17 in. by 12 in. outside, and made from patterns having a total depth of about 4 in. The vertical column at the back of the machine carries a double pattern plate fitted with automatic jawing device, which in the photograph is swung round almost out of sight. Above this is a swinging head carrying a pressure plate. Sand is filled into the lower portion of the machine, the pattern plate and upper box are then put into position, and the upper box filled with sand. The whole of the mould is rammed at one operation, the pattern plate is drawn and swung out of the way, and the mould closed. The lower ram then forces the complete mould upwards and out of the casting, whence it is removed by hand as shown in Fig. 19. The two parts of the mould are held together by a cast-iron band which surrounds the joint and is placed in position immediately before ramming so that it is half in each portion of the mould. The ramming pressure is from 4½ tons to 5 tons on the mould. A similar machine is made for circular moulds up to 23 in. diameter.

The standard hydraulic roll-over machine of the company is illustrated in Fig. 20. A somewhat larger machine of the same type was exhibited at Birmingham. It will take a rectangular box measuring 22 in. by 32 in., or the equivalent in other shapes, and rams it with a total pressure of 12 tons. The hydraulic pressure used for all the machines of this company is 750 lb. per square inch. The roll-over machine is specially recommended for very deep moulding. It has a draught of 23½ in. Ramming is done in two operations, the box being first half-filled with sand, which is consolidated by a thick wooden dummy plate being pressed round the mould. The box is then completely filled and again pressed. Some remarkably deep moulding was being shown at the exhibition, the pattern being of white metal with numerous loose pieces. The whole pattern with its loose pieces was made without any machining at all by Messrs. Bonvillain and Ronceray's method. Fig. 21, page 810, shows a very simple hand-pressure moulding machine by the same makers. Its method of operation is fairly obvious from the illustration. The box is placed over the pattern plate and filled. The head is then swung round and locked by the long T-headed bolt engaging with a catch. The workman then pulls down the lever, which forces down the pressure plate on to the sand by a rack and pinion gear, and effects the ramming. The head having been swung out of the way, the pressure of the operator's foot on a pedal draws the box from the pattern plate as shown in the illustration.

An oil-sand mixing machine for core sand, made by the Universal Moulding Machinery Company, is illustrated in Fig. 22. This is designed on the lines of a dough mixer, the two blades being geared together so as to run in opposite directions and at different speeds. For emptying, the machine can be tipped over by means of the hand lever shown. It will mix 5 gallons of sand and core oil in 3 minutes.

One complete bay of the Bingley Hall was laid out as a model foundry in workin gorder, and in this were held the moulding and core-making competitions to which reference has already been made. The machinery and appliances with which the model foundry was equipped were supplied by exhibitors selected by lot. At one end of the floor, Messrs. Crossley Brothers, Limited, of Openshaw, Manchester, had a somewhat imposing stand, laid out

EXHIBITS AT THE INTERNATIONAL FOUNDRY TRADES EXHIBITION, BIRMINGHAM.

CONSTRUCTED BY THE UNIVERSAL SYSTEM OF MACHINE MOULDING AND MACHINERY COMPANY, LIMITED, LONDON.

FIG. 19. HIGH-SPEED BOXLESS MOULDING MACHINE.

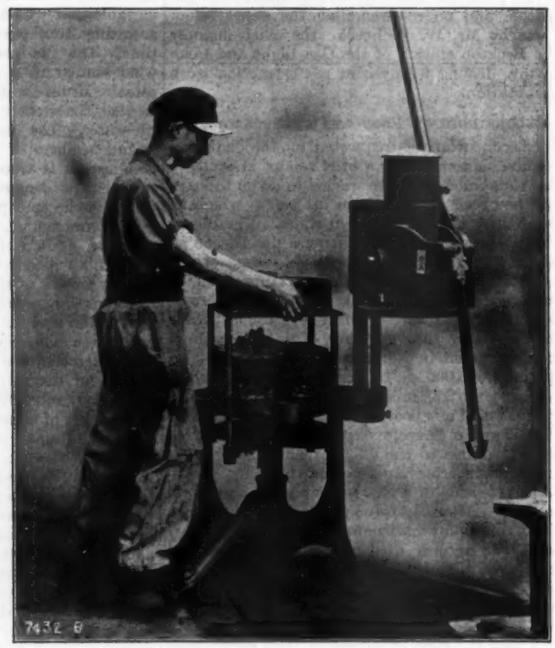


FIG. 21. HAND MOULDING MACHINE.

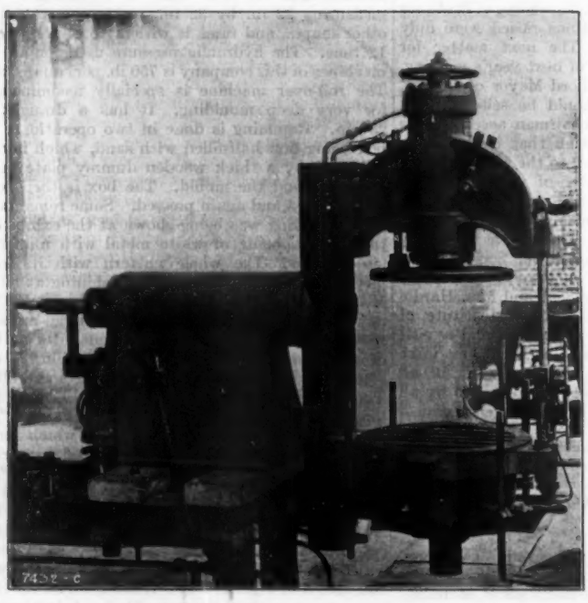


FIG. 20. ROLL-OVER MOULDING MACHINE.

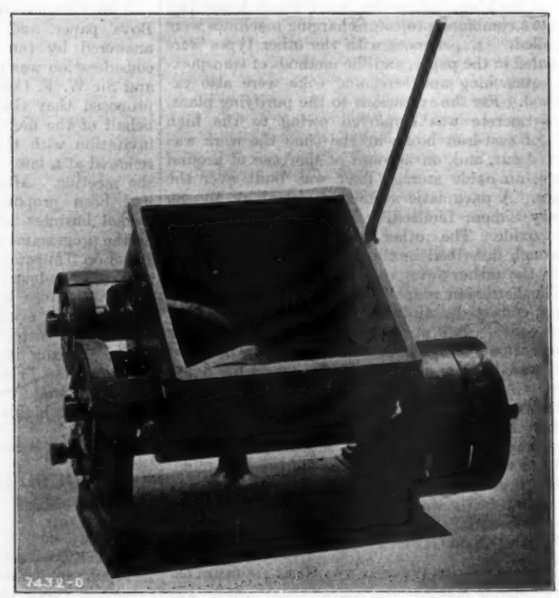


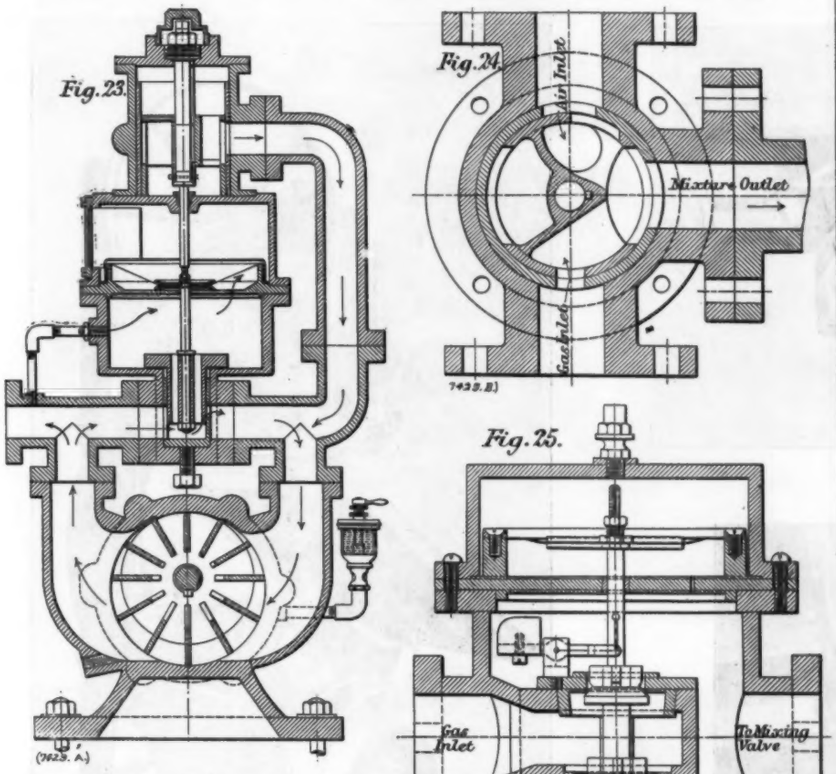
FIG. 22. OIL AND CORE-SAND MIXER.

to demonstrate the uses of producer gas in a foundry. Their exhibits comprised a producer gas plant complete with scrubbing, purifying, mixing and compressing machinery, delivering gas and air to two furnaces for melting brass and aluminium respectively, also to a small furnace for hardening or similar duties, and to various burners for drying out moulds, &c. The producer, which uses anthracite as fuel, is of Messrs. Crossley's open-hearth type which has the great practical advantage that the fire can be poked from the bottom, the operation being as simple as poking an ordinary domestic fire. Producers of this type have, we understand, been operated continuously for months on end without a stop of any kind. The one exhibited had a rated capacity of 5,000 cub. ft. of gas per hour, with a fuel consumption of about 56 lb. of anthracite per hour, the gas having a calorific value of about 130 B.Th.U. per cubic foot.

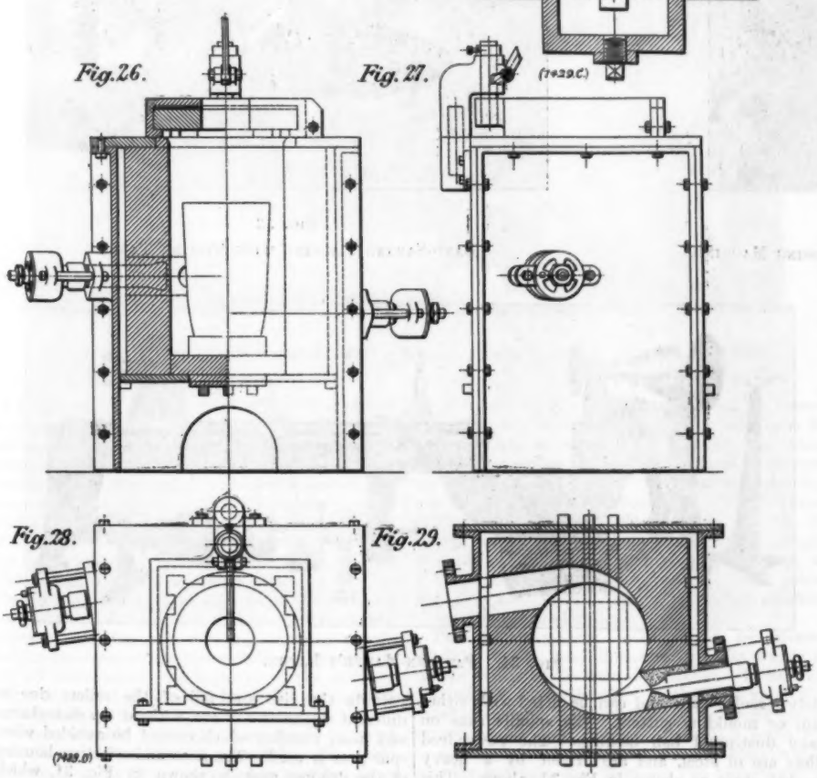
After passing through the usual coke scrubber and oxide purifier the gas which is then cool and perfectly clean enters the Docking gas and air compressor illustrated in Figs. 23, and 24, page 811. The rotary pump in the lower part of the machine is driven by a small Crossley gas engine running on producer gas. This pump, which has fibre blades pressed outwards against the eccentric casing by centrifugal force, draws air from the atmosphere and gas from the purifier in through the mixing valve at the top. A horizontal section through this valve is shown in Fig. 24. Its position in plan is adjustable by hand to suit different qualities of gas. When in the position shown the gas port is full open. Setting

EXHIBITS AT THE FOUNDRY EXHIBITION, BIRMINGHAM.

CONSTRUCTED BY MESSRS. CROSSLEY BROTHERS, LIMITED, ENGINEERS, MANCHESTER.



FIGS. 23 TO 25. "DOCKING" GAS COMPRESSOR AND MIXER.



FIGS. 26 TO 29. GAS-FIRED BRASS MELTING FURNACE.

the valve in either direction will diminish the opening of the gas port, and either increase or diminish the opening to air according to the direction. The gas and air mix inside the valve in proportions determined by the setting of the latter, and flow together to the suction side of the compressor. They are delivered at a pressure of 80 in. to 100 in. of water to an outlet on the other side. The delivery gas is in communication with the underside of a flexible diaphragm, and should the delivery pressure rise in consequence of less demand at the burners, the pressure raises the diaphragm and with it the central spindle of the machine. This does two things, firstly it raises the mixing valve and thus diminishes the port openings for any particular setting, and secondly it lifts the relief valve at the lower end of the spindle and allows the gas to pass back to the suction side of the compressor. By these means a perfect regulation of the delivery pressure is obtained and the proportions of the mixture are automatically kept constant.

When the Docking gas and air compressor is used to mix and deliver town gas and air, it is essential that the town gas shall be reduced to atmospheric pressure before it enters the mixing valve. This requirement is provided for by the device shown in Fig. 25. The gas enters by the branch on the left and has to pass through a balanced double-beat equilibrium valve. The spindle of this valve is connected to a diaphragm, the underside of which is in communication with the delivery side of the double-beat valve, through a small hole. Should the pressure on the delivery side of the valve rise above atmospheric, the diaphragm is lifted and the valve is closed sufficiently to throttle the gas by the required amount.

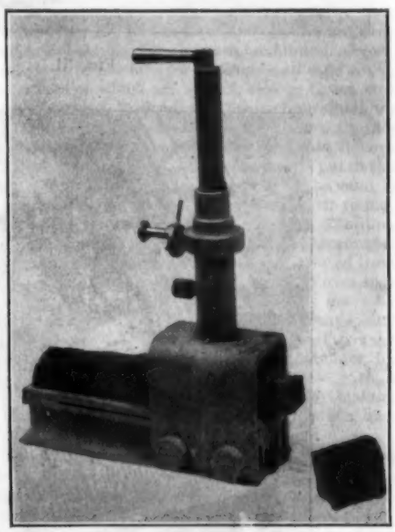


FIG. 30. THE TEMPLE-COX PIG-IRON BREAKER.

The brass-melting furnace, shown by Messrs. Crossley Brothers working in conjunction with their producer plant and the mixer just referred to, is illustrated in Figs. 26 to 29, annexed. It is sunk level with the foundry floor in the way usual for crucible furnaces. The crucible holds a charge of 150 lb., which can be melted in an hour. The furnace has two burners arranged tangentially at different levels. These are made of carborundum, which does not burn away like metal and will outlast several furnace linings. The burners are fitted with variable orifice injectors, so that the furnace can be turned over from town gas to producer gas, or *vice versâ* at a moment's notice. The gas consumption is 2,100 cub. ft. of producer gas or 600 cub. ft. town gas per hour.

In our last issue we described the Temple-Cox pig-breaking machine, which was exhibited on the stand of the United Brassfounders and Engineers,

EXHIBITS AT THE INTERNATIONAL FOUNDRY TRADES EXHIBITION, BIRMINGHAM.

CONSTRUCTED BY MESSRS. WADKIN AND CO., ENGINEERS, LEICESTER.

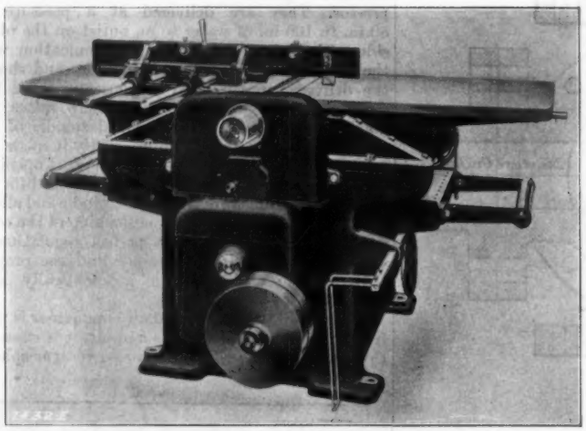


FIG. 31.

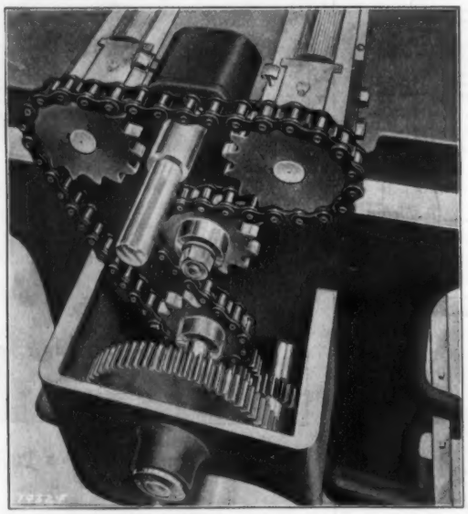


FIG. 32.

FIGS. 31 AND 32. SURFACING AND THICKNESSING MACHINE.

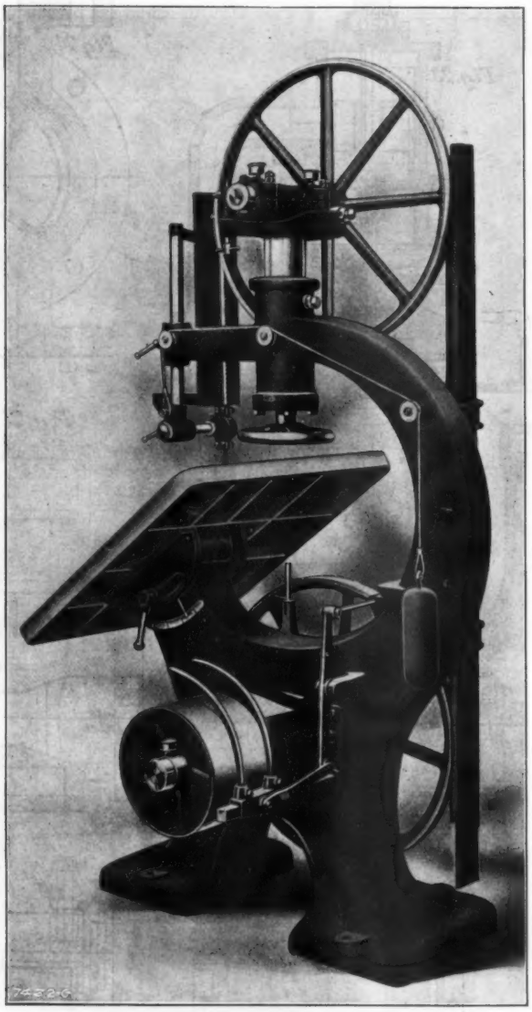


FIG. 33.

BAND-SAWING MACHINE WITH TILTING TABLE.

Limited, of Cornbrook, Manchester. This machine we now illustrate in Fig. 30, page 811. The pig, as we explained previously, is placed in the lower part of the machine and is broken by the descent of a 5 lb. tup which is propelled by the explosion of a small blank cartridge.

Messrs. Wadkin and Co., of Leicester, exhibited a great variety of wood-working machinery for the pattern shop. Their well-known universal pattern-making machine was shown in operation in order that the range of work which it will do might be demonstrated. The stand also contained the firm's latest design of surfacing and thicknessing machine, illustrated in Figs. 31 and 32, annexed. The surfacing table is 73 in. long overall and is scraped dead true, so that in spite of the large surface, it is possible to make perfect glued joints. The machine will surface 26 in. wide. The fence is arranged to cant 45 deg., and has two adjustable holding-down springs. The thicknessing table is 45 in. long and is provided with anti-friction rollers and carrying rollers for long work. It can be raised and lowered 9 in. by means of a hand wheel which operates well-enclosed screws by means of machine-cut steel bevel gears, the thrust of the screws being taken on ball bearings. The cutter block is of the two-knife safety circular type and can be fitted with either plain or moulding cutters. The spindle runs on heavy dust-proof ball bearings. The power-feed rollers are of steel, and are driven by a heavy sprocket chain as shown in Fig. 32, above. This permits the rise and fall of the rollers due to different thicknesses of cut, without the disturbance and noisy running which cannot be avoided when spur gear is used. The neat and effective housing of the driving gear is shown in Fig. 31, which

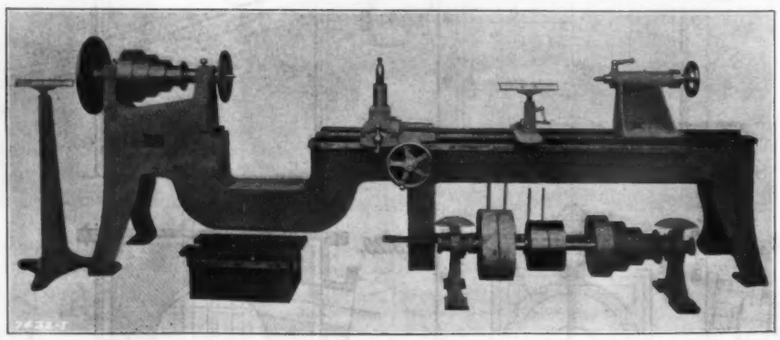


FIG. 34. PATTERN-MAKER'S LATHE.

EXHIBITS AT THE FOUNDRY EXHIBITION, BIRMINGHAM.

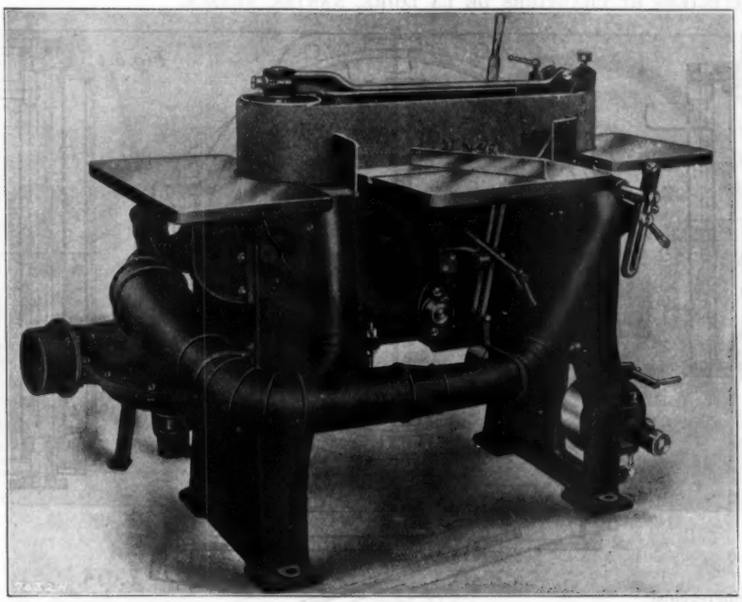


FIG. 35. VERTICAL RECIPROCATING SAND-BELT MACHINE; MESSRS. WADKIN AND CO., LEICESTER.

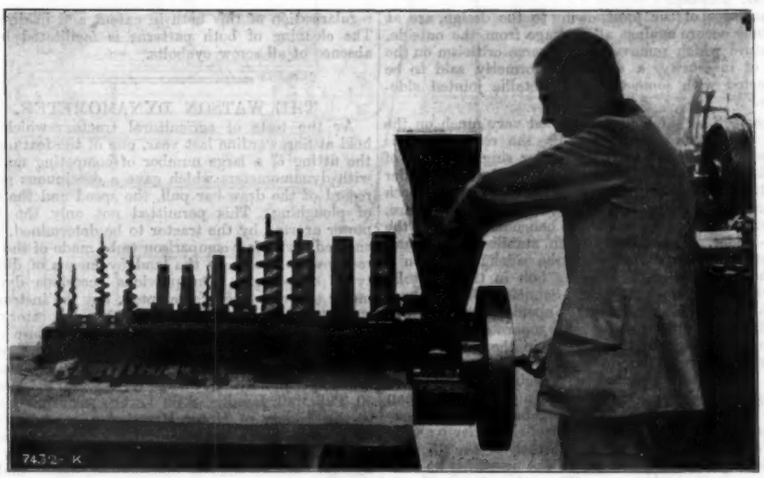


FIG. 36. ROTARY CORE-MAKING MACHINE; MESSRS. GEORGE GREEN AND CO., KEIGHLEY.

is a back view of the machine. Three rates of feed are provided, namely, 20, 30 and 40 ft. per minute, and the operator can change the speed by merely giving a partial turn to a handwheel in front of the machine. The feed may be instantly started and stopped, independently of the motion of the cutter block. The variable feed motion is driven by totally enclosed machine-cut gear running in oil. The machine can be fitted with the front surfacing table arranged to tilt, so that a pattern-maker can give his work the required amount of draft without hand labour. Rebating, moulding, tongueing and grooving, bevelling and mitreing, tapering newels, shaping hexagon or octagon newels, and panel-raising, all come within the capacity of the machine, which thus has a great scope for usefulness in wood-working shops.

Messrs. Wadkin & Co. also show the 30-in. band-saw, illustrated in Fig. 33, page 812. The table, which is 34 in. by 32 in., is carried on a rocker seated on a curved surface, with side flanges to ensure lateral rigidity in all positions. The table may be canted 45 deg. to one side, and 5 deg. to the other. The saw pulleys are covered with rubber, vulcanised on. The spindles run in ball bearings, the top bearing carrier being mounted on a vertical ram, supported on an adjustable spring to give the required tension to the saw. The machine weighs 12 cwts., and occupies a floor space of 54 in. by 42 in. A cut 14 in. deep can be made under the saw guide. The firm also build a somewhat larger machine of the same general design.

The pattern-makers' lathe shown by Messrs. Wadkin & Co., and illustrated in Fig. 34, is so simple as hardly to need description. It has one particularly handy feature, in that the spindle is extended behind the headstock, so that work can be turned at the end of the lathe, which could not be accommodated over the bed. The spindle runs in roller bearings, and there are two ball thrusts to take the end-pressure, which, of course, comes on in either direction according to which end of the spindle is being used.

A use ul type of wood-grinding machine, built by Messrs. Wadkin & Co., is the vertical reciprocating belt sander shown in Fig. 35, annexed. The sand-belt is carried on two drums mounted on a frame, which has a reciprocating motion up and down. The drums are of different sizes, the large one being provided with adjustable phosphor bronze bearings, while the smaller one runs in ball-bearings carried in a swivelling bracket, which has a lever adjustment for tightening the belt. There are three work tables, one opposite each drum and one opposite the flat part of the belt. The tables opposite the small drum and the flat part of the belt are arranged to cant, so that bevel work may be ground. These tables are also adjustable to and from the belt. The side table is fitted with a universal swivelling fence, so that plain and compound angular work can be readily dealt with. By this machine all kinds of flat and curved work with either square or bevelled edges can be ground accurately to shape in a fraction of the time taken by hand. Work direct from the saw can be cleaned up to shape easily and rapidly. An exhausting fan takes the dust from two points as shown.

Messrs. J. R. Richardson and Sons, Limited, Commercial-street, Birmingham, exhibited a very simple type of machine for making small sand cores, the makers of which are Messrs. George Green and Co., of Keighley, Yorkshire. The machine which we illustrate in Fig 36, annexed, is almost exactly like the domestic sausage machine, except that it contains only a single spiral. The core sand is put in the hopper and when the handle is turned, the sand is forced by the spiral through a die, of either round, rectangular, hexagon or elliptical section according to the sort of core required. The spiral terminates in a long point so that the cores are well vented from end to end. They are delivered on to grooves in a tray 2 ft. long, cores of this length being made by hand at the rate of 5 seconds to 30 seconds each according to size. The machine can be used to make cores from $\frac{3}{8}$ in. diameter to 3 in. diameter by changing the dies and spirals. Complete with a dozen core trays and dies and spirals for making 19 different sizes of core, the weight of the machine is only 150 lb.

Among the firms which we can only mention briefly on account of shortness of space, are the Britannia Foundry Company, Limited, of Cox-street, Coventry, who showed pneumatic jolt-ramming and pressure-ramming moulding machines of their well-known types; the Pneulec Machine Company, Limited, of Roebuck-lane, Smethwick, Birmingham, who also showed many moulding machines, including an electrically operated jar-ramming machine with a 9-in. pattern draw, capable of taking moulds up to 15 cwt. in weight. The stand of this company also contained a roll-over moulding and core-making machine taking boxes 30 in. by 24 in. and having a pattern draw of 18 in. A solid-looking, simple and useful kind of hand-operated moulding machine was shown by the General Foundry and Engineering Company, Limited, of Lutterworth, Leicestershire, and Messrs. Samuelson and Co., Limited, of Banbury, also showed simple moulding machines for the lighter classes of work. Among the large moulding machines, the Tabor machines shown by Messrs. Macnab and Co., Limited, of 56 to 58, Eagle-street, London, W.C. 1, ought certainly to be mentioned. These are air-operated machines of both the jolt-ramming and pressing types, and are built to take boxes up to several tons in weight. Messrs. Alldays and Onions, Limited, of Great Western Works, Birmingham, showed a cupola plant, capable of melting up to 2 tons per hour, complete with staging and hand-operated hoist. Messrs. Alfred Herbert, Limited, Coventry, exhibited one of their sand-mixing machines, fitted with dust-proof oiltight ball bearings, and with case-hardened gears running in oil. The principle on which the machine works is the passage of the sand through four rings of bars rotating alternately in opposite directions. The machine will deal with 3·5 cwt. of sand per minute. On the same stand was a Brinell hardness testing

SHIP SIDELIGHTS.

CONSTRUCTED BY THE ATELIERS ET CHANTIERS DE LA LOIRE, NANTES, FRANCE.

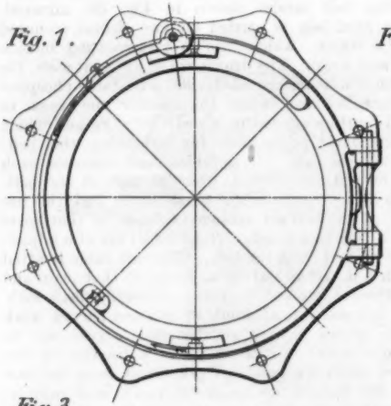


Fig. 1.

Fig. 2.

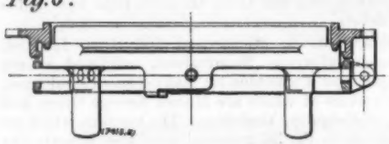


Fig. 3.

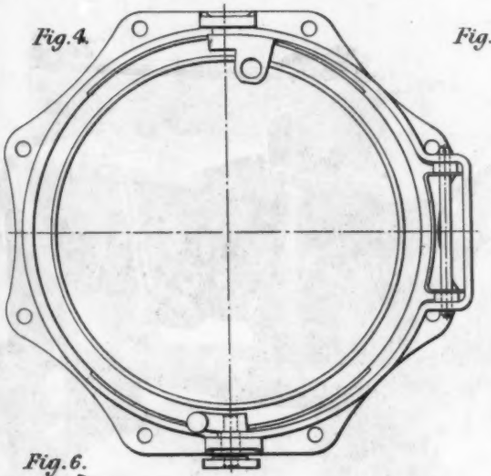


Fig. 4.

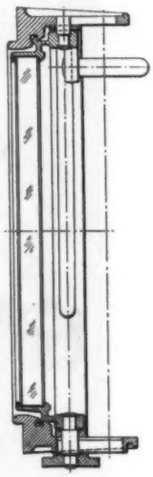


Fig. 5.

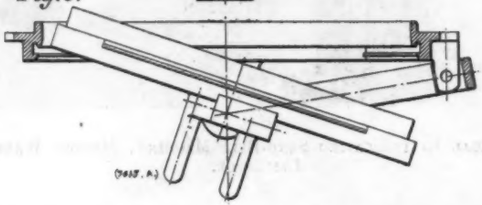


Fig. 6.

machine. Messrs. W. and T. Avery, Limited, of Soho Works, Birmingham, also showed a Brinell machine as well as examples of their well-known weighing machines.

Messrs. W. Beardmore, Limited, of Glasgow, were represented by models of steel castings up to more than 50 tons in weight, including rudders, rudder frames, press heads, &c. Messrs. N. Hingley and Sons, Limited, of Netherton Iron Works and Old Hill Blast Furnaces, Dudley, showed specimens of special foundry pig-irons. The Shotts Iron Company, Limited, of 1, Castle-street, Edinburgh, also showed pigs of various qualities and some excellent castings made from them. Grinding machines of the double-headed floor type were exhibited by Messrs. B. R. Rowland and Co., Limited, of Reddish, near Stockport, and swing grinders by A. W. Sainsbury, Limited, Campo-lane, Sheffield. The Cambridge and Paul Instrument Company, Limited, of 45, Grosvenor-place, London, S.W. 1, and the Foster Instrument Company, Limited, both exhibited a large range of pyrometers and other instruments.

SHIP SIDELIGHTS.

We illustrate on this page a new type of ship sidelights, the invention of Mr. C. Lauprête and brought out by the Société Anonyme des Ateliers et Chantiers de la Loire, Nantes. Specimens of these are to be shown at the forthcoming summer meeting in Paris of the Institution of Naval Architects.

In practically all sidelights hitherto used, watertightness is insured by means of an indiarubber ring which, when the sidelight is closed, is pressed between the fixed frame and the glass-holder. In these, however, tightness is liable to become impaired by the gradual deterioration of the indiarubber, owing to the combined action of the sea water, heat and repeated opening and closing of the sidelights; the effect upon the ring of repeated opening and closing is increased when the sidelights are provided with a safety closing device.

The sidelights we illustrate are made entirely of brass, including the internal dead window. The external dead window can be made of cast-iron and be galvanised if necessary. They are styled by the manufacturers "75 S." and are of two patterns, a hinged pattern (75 S.H.), Figs. 1 to 3, and a pivoting pattern (75 S.P.), Figs. 4 to 6. The first, the hinged pattern, is the one generally adopted for all sizes of sidelights, including those of large diameter, whilst the second, the pivoting pattern, is used as a rule for large diameter lights only, in ships' saloons and cabins de luxe. Both are easily and rapidly operated, one of their main advantages lying in the fact that indiarubber is entirely done away with, there being a perfectly tight metal-to-metal joint between the fixed frame and the glass-holder, or, as the case may be, between the dead window and the glass-holder, no separate ring of any kind being required to ensure tightness. The joint may be likened to the fitting of an ordinary water-cock upon its seat. The bearing surfaces of the joint, owing to the design, are at all times secure against all damage from the outside, a feature which removes any adverse criticism on the plea of insecurity, a drawback formerly said to be connected with some types of metallic jointed sidelights.

The 75 S.H. sidelight is designed very much on the lines of the de Bange breech; the resemblance is almost complete between its carrier ring and that of the de Bange breech, as also between the glass-holder and the breech-block made with threaded and smooth sectors; the threads in the gun breech-block are, however, replaced by one single helicoidal guide on the glass-holder. The device which stabilises the glass-holder in its carrier-ring when the sidelight is open is on the principle of the locking bolt in the Lahitolle breech mechanism. As in the Schneider 75-mm. gun, in which it is not necessary for opening the breech to withdraw the breech screw by a separate longitudinal pulling-out action in the rear, so in the sidelights we illustrate there is also no distinct withdrawal action upon the glass-holder before swinging it open; the sidelight mechanism, therefore, is much simpler than those of the de Bange and Lahitolle breech mechanisms above referred to. Another point of similarity between the 75 S.H. sidelight and the breech of the 75 mm. gun is that the arrangement of the operating handles is the same in both cases. When the glass-holder is brought near the fixed frame in the closing action, the end of the locking bolt is acted upon by a projection on the fixed frame, when the glass-holder can take a part turn and ensure tightness of the metal-to-metal joint, the bolt at the same time being driven home, under the action of a small spiral spring. A closing stop automatically limits the part-turn to the amount needed for ensuring the tightness of the joint, an important feature which renders overturning impossible, and makes for the easy opening of the sidelight after it has remained closed for any considerable time. When it is necessary, owing to wear after long service, to increase the amplitude of the part-turn in closing in order to obtain tightness, a slight filing of the closing stop is all that is required.

The 75 S.H. sidelights can be fitted with an internal watertight dead window also having a metal-to-metal joint, or with an external, non-watertight dead window, or with both. When fitted with an internal one, which takes the place of the hinged dead window in the ordinary type of sidelights, this can be made to open either to the right hand or to the left. A safety device renders the 75 S. sidelights entirely fool-proof in the emigrants' quarters. The 75 S.P. pattern is most suitable for large diameters, as above stated; it is quite as secure and as easy to operate as the hinged pattern. It allows of ample ventilation and the regularisation of this both in extent and in direction. The cleaning of both patterns is facilitated by the absence of all screw eyebolts.

THE WATSON DYNAMOMETER.

At the tests of agricultural tractors which were held at Shrawardine last year, one of the features was the fitting of a large number of competing machines with dynamometers which gave a continuous graphic record of the draw-bar pull, the speed and the depth of ploughing. This permitted not only the horse-power exerted by the tractor to be determined, but it enabled also a fair comparison to be made of the effort required to break up the land by means of different types of ploughs. On previous occasions dynamometer trials had been attempted, but the instruments employed had been too much of the laboratory type and unequal to the exceedingly severe nature of the work. The advisability of securing actual records of the performance of the various machines entered for competition led Mr. George W. Watson, M.I.Mech.E., 50, Pall Mall, London, S.W. 1, the consulting engineer to the Society of Motor Manufacturers and Traders, to design a dynamometer suitable for the purpose and, at the Shrawardine trials, his apparatus was used throughout. It proved entirely successful and has since been adopted by the British and other Governments for the testing of haulage appliances of various kinds.

The Watson dynamometer is illustrated in Figs. 1 to 9, on page 815. Fig. 1 shows the general appearance of the instrument standing by itself, and Fig. 2 shows the recording mechanism with the cover removed. The construction will be understood from Figs. 3 to 9. The dynamometer is, of course, placed between the tractor and the plough or other implement which is being pulled, and itself transmits the draw-bar pull. The tractor and plough are connected respectively to the levers A and B in Fig. 3. Lever A is rigidly bolted to the frame of the dynamometer, while lever B has a fulcrum connection as shown, so that a pull on the lower part of the lever causes the hardened steel ball mounted at the upper end to press against the end of a piston rod which projects from the instrument. The piston attached to the rod works in a cylinder C containing oil which resists the motion of the piston. It will be noted that each of the levers A and B has two holes in its lower part. These provide two ranges for the instrument, for if the attachments are made to the lower pair of holes, the leverage on the piston is twice as great as if the upper pair are used, and consequently the oil pressure in the cylinder due to a given pull is doubled. This oil pressure is transmitted by an external pipe to the interior of a small

RECORDING DYNAMOMETER FOR TRACTORS.

MR. GEO. W. WATSON, M.I.MECH.E., ENGINEER, LONDON.

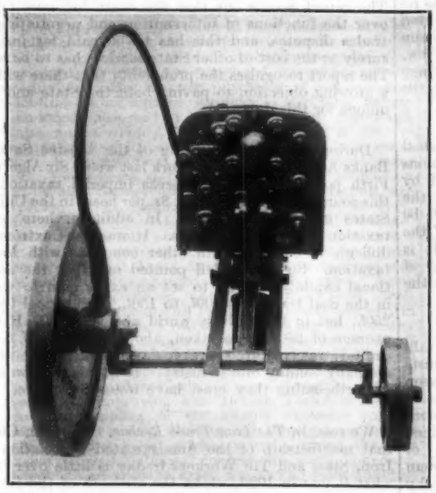


FIG. 1.

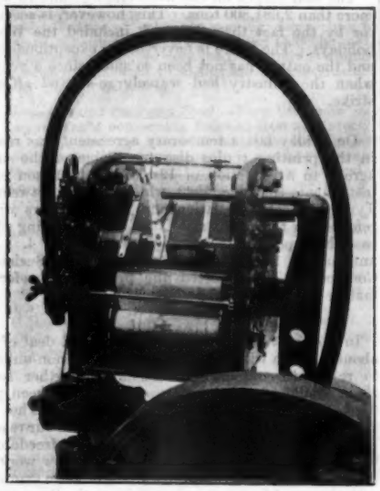
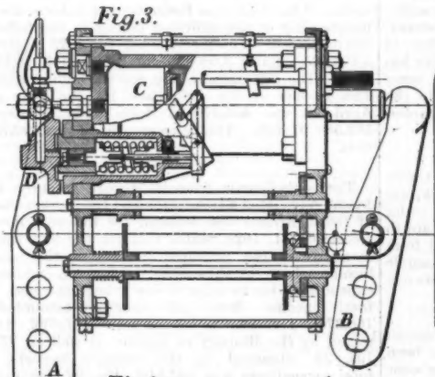
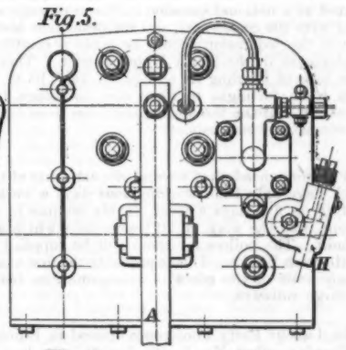
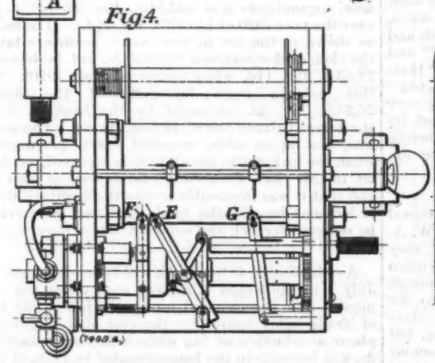
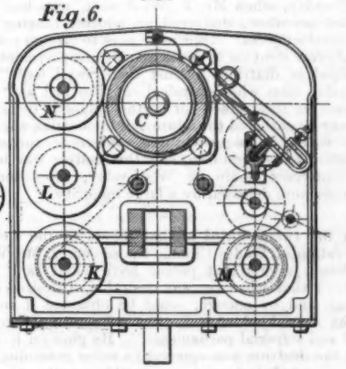


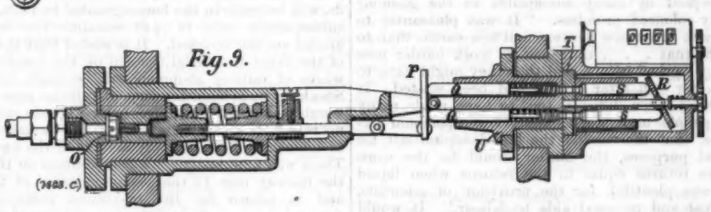
FIG. 2.

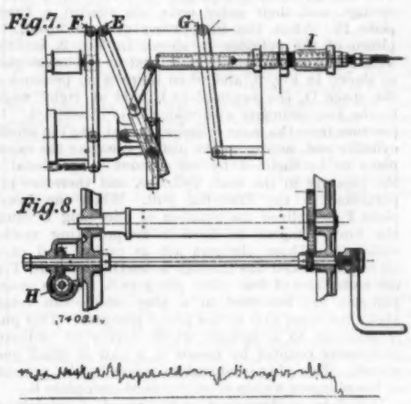


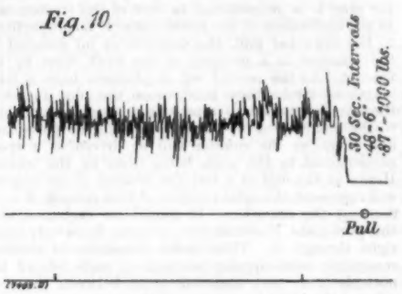












cylinder D, in which it acts upon the underside of a spring controlled piston. It is clear that the motion of this piston will be proportioned to the oil pressure, and therefore to the draw-bar pull.

A small crosshead is attached to the rod of this small piston, and this in its turn is connected to a stylus lever by a link motion, so that the stylus point E moves in an approximately straight line and reproduces the motion of the piston to a magnified scale. The stylus point bears upon the upper surface of a roll of paper which passes over the cylinder C, as shown in Fig. 6. Beneath this roll of paper is a roll of carbon paper with its treated surface uppermost, so that when the stylus moves on the upper roll, the lower side of this roll is marked accordingly. Both rolls of paper are caused to travel at a speed directly proportional to that of the tractor. The motion of the paper is obtained by a flexible shaft drive from the castor wheel, as shown in Figs. 1 and 2. The flexible shaft terminates in a worm gear, the wheel of which drives a spur wheel on the feed roll over which the plain paper passes. The worm and wheel are illustrated in Fig. 8. This feed roll has a number of spiked projections which engage the edges of the paper and provide a positive drive. The same spur wheel also drives a chain sprocket wheel, which in its turn drives the flanged reel M, Fig. 6, by friction. On to this reel the used paper is wound. On the opposite side of the instrument is a corresponding reel K driven by a chain connecting the two sprockets. On this reel is wound the used carbon paper. As both these reels are driven by friction, slippage can take place to compensate for the increased diameter of the rolls as the reels become filled. The plain paper is supplied to the recording cylinder from the reel N and the carbon paper by the reel L.

In order to provide on the chart a record of the time during any particular test, there is a second lever pivoted to the casing, and terminating in the stylus F. This lever is controlled by a spring, and it carries a soft iron pole-piece opposite to a small electromagnet. This magnet is momentarily excited at half-minute intervals by a battery circuit interrupted by clockwork. Kinks are thus made every half-minute in the otherwise straight line which the stylus makes on the moving paper. As the paper moves proportionately to the speed of the tractor, the speed of travel can be calculated at any point by the distance between the kinks.

The third record which has to be made is that of the depth of the furrow being ploughed. To do this a bracket is cramped to the plough frame and hinged to the bracket is a stirrup carrying a castor wheel which runs on the ground. The stirrup acts as a bell-crank lever, and the deeper the plough share is in the ground, the more will the stirrup be rotated about its point of support. To the shorter arm of the bell-crank lever is attached a Bowden wire which is pulled proportionately to the rotation of the stirrup, and therefore to the depth of the furrow. The other end of the Bowden wire actuates the lever shown in Figs. 4 and 7, which has at its end the recording stylus G. This stylus, therefore, records the depth of the furrow as the tractor progresses.

Besides performing the three functions which have been described, the dynamometer is also arranged to integrate when required. The integrating mechanism is not shown in Fig. 3, but is illustrated separately in

Fig. 9. In the right-hand end-plate of the machine is fixed a bushing inside which there is a plug U containing four plungers A parallel with the axis of the plug. The plug is rotated by the gear wheel shown, and runs at a speed proportional to that of the tractor. The four plungers are pressed outwards by means of springs, and their outer ends run against a swash-plate P. When the integrating gear is fitted, the piston of the cylinder D, shown in Fig. 3, is fitted with a longer rod, which is coupled to the swash-plate as shown in Fig. 9, and when there is no pressure on the space O, the swash-plate is held at right angles to the four plungers with which it is in contact. Oil pressure from the main cylinder C is led into the smaller cylinder and, acting on the piston, it causes the swash-plate to be inclined by an amount proportional to the pressure in the main cylinder, and therefore proportional to the draw-bar pull. When the swash-plate P is inclined the rotation of the plug U causes the four plungers to have a reciprocating motion within it. These plungers act as pumps and cause oil to pass to and fro through a fixed port-plate T to the undersides of four other plungers S. These second plungers are mounted in a plug which can rotate about the same axis as the pump plungers. This plug is fastened to a spindle which drives an ordinary cyclometer counter by means of a pair of small gear wheels. This plug is caused to rotate by the pressure of the plungers within it on the fixed cam-plate R.

It will be evident that as the speed of rotation of the plug U is proportional to that of the tractor, and as the inclination of the swash-plate P is proportional to the draw-bar pull, the quantity of oil pumped by the plungers is a measure of the work done by the tractor. As the second set of plungers have a fixed length of stroke they must cause the plug in which they are contained to rotate at a speed proportional to the quantity of oil pumped through the port-plate, and therefore the counter will be driven at a speed proportional to the work being done by the tractor. Hence at the end of a test the reading of the counter will represent the total number of foot-pounds of work done at the draw-bar. It should be explained that the port-plate T contains two circular holes only going right through it. These holes terminate in shallow, concentric semi-circular recesses on each side of the port-plate, so that communication between the two sides of the plate is maintained throughout a complete stroke of each pump plunger.

Fig. 10 is a half-size reproduction of an actual chart drawn by a Watson dynamometer during the Shrawardine trials. The uppermost record shows graphically the depth of the furrow to a scale on the actual chart, of one-twelfth full size, the zero line being the straight line next below the record. The central record shows the draw-bar pull, the scale in this case being 0·875 in. equals 1,000 lb., measured from the line of zero pull below. The straight line on the bottom of the chart is the time record, the distance between two kinks in the line showing the distance travelled in half a minute. As the chart moves under the stylus at the rate of 1·375 in. for each 100 ft. of travel of the tractor, the distance travelled in any half minute interval can be measured on the diagram and the speed computed. We may mention the fact that the dynamometer which made this record was inadvertently left unattended during the trials, and at their conclusion it was found to have produced a complete and perfect record covering a period of 4·75 hours of continuous working, and a distance of nearly 12 miles.

Demonstrations of the dynamometer in actual operation will be given at the Royal Agricultural Society's Show at Cambridge next week, where the instrument has been entered by Messrs. H. G. Burford and Co., Limited, as under the class of new implements.

INDUSTRIAL NOTES.

THE *Labour Gazette* reports that employment in May was slightly better than in April. The percentage unemployed among members of trade unions from which returns were received was 16·4 at the end of May, compared with 17 at the end of the previous month. The percentage among workpeople coming under the Insurance Act was 13·5 on May 22, compared with 14·4 on April 24. The total number of workpeople registered at Employment Exchanges on May 22 was approximately 1,566,000, of whom 1,264,000 were men, 218,000 women, and the remainder boys and girls.

Wages fell in May, the changes reported to the department showing a total reduction of 390,000*l.* in the weekly full-time wages of 2,200,000 people. The increases reported amounted to 4,000*l.*, affecting 175,000 workpeople.

The trades disputes reported as beginning in May were 38, while 58 other disputes which were carried over from April were still in progress. The total number of workers affected was about 370,000, compared with 270,000 in the previous month, and 1,170,000 in May, 1921. The working days lost in May this year are estimated at 7,200,000.

The coal output for the week ending June 10 was no more than 2,681,800 tons. This, however, is accounted for by the fact that the week included the Whitsun holidays. The figure is nevertheless exceptionally low, and the output has not been so small since a year ago when the industry had scarcely re-started after the strike.

On Friday last a temporary agreement was reached in the printing trades dispute. Some of the unions agreed to a reduction of 12*s.* 6*d.* to be taken off by instalments till June, 1923, while the case between the Typographical Association and the employers will be referred to the Industrial Court. The hearing of the case is expected to take place on July 4. It is announced, however, that the London Society of Compositors has rejected the proposal to refer the matter to the Industrial Court.

In South Wales there has been a good deal of talk about a strike with a view to compelling non-unionists to rejoin the miners' federation. A further reason given is alleged victimisation said to have been practised by employers in various districts. The consistency of these two pretexts will appeal to our readers. The federation miners claim perfect freedom of behaviour under the employer, but no fellow workman is to be free to live as he wishes unless he be in sympathy with them. At a meeting last Friday, the South Wales Miners' Federation at Cardiff passed two resolutions. One was to the effect that non-unionism should be treated as a national question in the next wage settlement with the coalowners, and the other that membership of the federation should be made a condition of employment in the South Wales district. There has been talk of handing in notices on July 10 to cease work for a fortnight to force men to return to the federation, but the threat does not seem to be regarded at present very seriously.

It is announced that several departments at Crewe which have only been working four days a week, are starting on five days a week for six months in order to cope with the work on 20 locomotives which are to be built. The boilers for these will be supplied from the Horwich Works. This is probably the first example on any scale of the effect of amalgamations between the large railways.

The Labour Party Conference opened in Edinburgh on Tuesday, when Mr. F. W. Jowett, who had been elected president, delivered an address ranging over the usual subjects. After references to foreign politics, Mr. Jowett went on to speak about unemployment, and indulged in diatribes against the "swell mob" and capitalist class who controlled supplies just as "their idleness or their greed for further plunder dictated." As may be gathered the address did not strike any very lofty note. Subsequently the conference turned its attention to communism, but this matter was before the conference again on Wednesday, when the extremists were defeated by a large majority.

In the twenty-third annual report of the General Federation of Trades Unions, the secretary, Mr. W. A. Appleton, says "that people have acted as if they believed that whatever was desirable, if desired often enough and by enough, could be obtained if enough of the right kind of legislators were returned to the local and imperial parliaments." He goes on to state that the doctrine was opposed to sober reasoning, but was accepted by many susceptible to the glamour of highly-coloured promises. "It was pleasanter to talk to men about new heavens and new earths than to tell them that . . . they had to work harder now than they worked before, and that they might have to work harder still after capital had been wasted. It would have been difficult, too, to have made many of the people understand, apart from personal experiences, that the smaller the liquid capital left for industrial purposes, the harder would be the work to secure returns equal to the returns when liquid capital was plentiful, for the provision of scientific, mechanical and personal aids to labour." It would have been well, we think, if views more in accord with the economics sketched above had been traceable in the presidential address delivered at Edinburgh on Tuesday.

The General Federation of Trades Unions, like other associations of the kind, has suffered a considerable loss in membership in the past year. The decrease involves a reduction of no less than 211,424, attributed in the report (1) to the increasing poverty of men and women both in respect of employment and returns from employment, and (2) to the increased absorption by the State of functions at one time almost wholly performed by the trades unions and friendly societies. The report points out that the State has now taken over the functions of intervention and negotiation in trades disputes, and this has to be paid for just as surely as the cost of other State services has to be met. The report recognises the probability that there will be a growing objection to paying both the State and the unions for this duty.

During the annual meeting of the Trustee Savings Banks Association, held in York last week, Sir Algernon Firth pointed out that whereas imperial taxation in this country amounted to 20*l.* 8*s.* per head, in the United States it was only 7*l.* 6*s.* In addition, here local taxation amounted to 4*l.* 2*s.* It was thus extremely difficult to compete with other countries with lower taxation. Sir Hugh Bell pointed out that the additional capital required to set an extra man to work in the coal trade was 100*l.* to 150*l.*, in the steel trade 250*l.*, but in the railway world about 1,600*l.* If the average of 250*l.* were taken, about 110,000*l.* of fresh capital was required every day to start the men normally coming into industry. If that capital was to be forthcoming they must have industrial peace.

We read in *The Iron Trade Review*, Cleveland, Ohio, that membership of the Amalgamated Association of Iron, Steel and Tin Workers to-day is little over half what it was in 1920, whilst the strength of the International Union of Mine, Mill and Smelter Workers, is now little more than one-fifth of the 1920 figure. According to the annual report of the executive committee of the American Federation of Labour, the total membership of the affiliated unions in the federation has decreased. The membership for 1922 is given as 3,195,635, against 3,906,258 for 1921 and 4,078,740 for 1920. The 1920 membership was the highest recorded. The income of the federation for the year ended April 30 was 583,120·13 dols., and the expenses 562,588·07 dols. The balance in hand was 196,794·08 dols.

The sixty-fourth financial report recently issued by the Associated Blacksmiths and Ironworkers Society of Great Britain and Ireland, for the year down to December 31, 1921, states that for the first time for many years the principal sources of the society's income show a substantial reduction, whilst the expenditure for benefits shows a huge increase. The total income from all sources amounted to 166,376*l.* 17*s.* 8*d.*, which includes 101,056*l.* 2*s.* 3*d.* repaid by the Ministry of Labour, as well as 25,345*l.* 19*s.* 3*d.* advanced by the society's bankers. The total expenditure was 192,849*l.* 15*s.* 9*d.* (an increase over the year 1920 of 140,537*l.* 15*s.* 4½*d.*). The balance, as shown in the net income and expenditure table at the close of the year, was 43,955*l.* 3*s.* 11*d.* (a decrease of 28,651*l.* 19*s.* 11*d.* when compared with 1920). From this balance must be deducted the sum of 25,345*l.* 19*s.* 3*d.* advanced by the bankers, making the actual balance one of 18,609*l.* 4*s.* 8*d.* The average loss, the report adds, exceeded 1,000*l.* per week, and when the lock-out in the shipyards occurred, on March 29, of this year, the society's funds were at such a low ebb that it was impossible to pay the members' dispute or lock-out benefit, the funds that were left having to be reserved for sick and superannuation purposes.

A reduction of 4*s.* per week will be made on and from July 1 in the wages of railway men under the agreement. This is accounted for by the fall in the Board of Trade index figures for the cost of living, bringing about a reduction of 2*s.*, while a further reduction of 2*s.* will be made in the bonus granted in 1919, of which subsequently only 1*s.* will remain. The locomotive grades are not touched. It is stated that the decision of the Joint Industrial Council on the question of the wages of railway shopmen will be made next week. Speaking to a mass meeting of railway men in Edinburgh on Sunday last, Mr. J. H. Thomas said he had no reason to think that the companies had any wish or intention of making any attack on the agreements. There was a necessity for a contribution on the part of the railway men to the economic needs of the times, and in return for the maximum conditions they demanded it was their duty to put forward the maximum effort in payment for those conditions.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—A metropolitan district meeting is to be held at Ashby-de-la-Zouch on Thursday, July 6, during which the manufacture of sewerage and drainage pipes and other ware goods at invitation of Messrs. John Knowles and Co., will be inspected.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Improvement throughout the local iron and steel trades is maintained at a steady rate, though tremendous headway will have to be made before anything approaching normal conditions is restored. Trade organisers, while hopeful, do not endorse highly optimistic reports, realising that the uphill climb will be long and arduous. Movement in basic materials is more pronounced. Stocks at manufacturing works are light, and as arrangements to place in hand suspended contracts and new orders are completed, buyers are coming steadily forward. Heavier purchases of pig-iron and hematites are anticipated, surpluses of steel scrap having been largely absorbed by the recent demand from South Wales and Germany. A favourable sign is the re-starting of steel furnaces which for months have stood idle. At Messrs. Steel, Peach and Tozer's Rotherham works, for instance, steps are proceeding to recommission six of the battery of 14 furnaces. Operations are expected to be resumed about the middle of July, affording employment for about 700 additional workmen. Steel users generally are beginning to realise that except for fractional reductions, values have reached their lowest, and that any substantial rise in business will probably be accompanied by increased rates. Much depends on coal prices. At their current level, steel-makers can compete with foreign producers and are, in fact, benefiting from a revived overseas inquiry, but any expansion in fuel costs will quickly sprag development. Makers of industrial machinery are moderately occupied and have fair prospects; Colonial and foreign trade in this connection shows welcome signs of revival. Mining steel is an improving line, though Yorkshire colliery concerns complain of the alleged excessive cost of materials and stores. Rolling mills largely dependent on colliery orders have suffered acutely during the past twelve months. Railway orders are more abundant, though export trade in axles, wheels and tyres would be greatly stimulated if prices were reduced proportionately as in other sections. Spring makers are taking steps to effect economies in production costs. Firms in this area are sharing in the work of supplying a heavy tonnage of cast-iron segments to the London Electric Railways. Activity in shipbuilding materials is greatly restricted. Sheffield works will benefit slightly from the contract placed with Messrs. Cammell Laird and Co. by the United Fruit Company, U.S.A., for the supply of three motor ships, each of about 4,000 tons gross for use in the fruit-carrying trade. The lighter industries afford instances of considerable activity, notably in saws, spades and joiners' tools. Big consignments of circular saws are being made for Japan; forks and machine knives are on order for the Colonies; and files are slowly improving. Wire mills have difficulty in disposing of their output, though there is an upward movement in mild steel wire. Springs are being successfully made from rustless steel, and experiments are being carried out in rustless rope for colliery work.

South Yorkshire Coal Trade.—Further weakness in best house coal is reflected in reductions ranging from 1*s.* to 2*s.* in Derbyshire sorts. Best steams have not yet recovered from the recent setback. The home demand is at the minimum, and export requirements are only very moderate. Cobbles and nuts continue a poor market. Holding heavy stocks, collieries are open to accept special rates for prompt business. On the other hand, the restriction of working at local pits has produced a shortage of slacks, which have advanced 6*d.* on the week. Both furnace and foundry coke are in fair demand, business having been stimulated by the engineering settlement, but gas coke is decidedly weak. Quotations:—Best branch handpicked, 36*s.* to 37*s.*; Barnsley best Silkstone, 33*s.* to 34*s.*; Derbyshire best brights, 27*s.* to 28*s.* 6*d.*; Derbyshire best house, 23*s.* to 25*s.*; Derbyshire best large nuts, 21*s.* to 22*s.*; Derbyshire best small nuts, 15*s.* to 16*s.* 6*d.*; Yorkshire hards, 23*s.* to 24*s.*; Derbyshire hards, 21*s.* to 23*s.*; rough slacks, 8*s.* 6*d.* to 10*s.* 6*d.*; nutty slacks, 7*s.* 6*d.* to 8*s.* 6*d.*; smalls, 3*s.* to 5*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The market keeps steady with only a moderate business passing. Export demand for Cleveland pig-iron is disappointing, but home inquiries are a little better, and, though with the exception of No. 1 and siliceous qualities, production is in excess of requirements, tempted by prospect of larger needs for home purposes output is being increased. A distinctly more hopeful tone is noticeable, but the opinion prevails that movement towards restoration of normal conditions will be very gradual. Business with Scotland has shrunk to almost vanishing point. What few small sales are made to customers beyond the Tweed are based on 96*s.* 8*d.* f.o.t. Grangemouth for No. 3. All other trade, both on home and export account is conducted on the usual f.o.t. makers' works or f.o.b. Tees terms, and quotations remain:—No. 1, and siliceous iron, 95*s.*; No. 3 G.M.B., 90*s.*; No. 4 foundry, 87*s.* 6*d.*; No. 4 forge, 85*s.*; and mottled and white, 80*s.* American inquiries for Cleveland foundry pig-iron as well as for special qualities, continue, and further sales to the States are anticipated.

Hematite.—A slightly better feeling in East Coast hematite is noticeable, and in this branch also, notwithstanding present very plentiful supply, hope and belief that trade will expand, is inducing makers to blow in one or two more furnaces. With consuming industries slowly resuming work home orders are expected to expand, but beyond a little buying for Germany, Continental trade is extremely quiet. Nos. 1, 2 and 3 are 95*s.*, and No. 1 is 96*s.*

Foreign Ore.—There is no new feature in foreign ore. Sales of occasional cargoes are reported, generally at below recognised market quotations, which are 27*s.* c.i.f. Tees for best rubio, and 23*s.* 6*d.* c.i.f. Tees for good Mediterranean ores.

Coke.—Values of coke are coming down, but there are some sanguine makers who predict that the markets will stiffen again before very long. Supply is abundant, and Durham, medium blast-furnace descriptions are on sale at 26*s.* 6*d.* delivered.

Manufactured Iron and Steel.—Very little new indeed is ascertainable concerning finished iron and steel, but what slight changes are noticeable are for the better. There is just a little more moving in one or two branches of the steel industry, and inquiries have resulted in a few orders being booked. There is, however, still a vast proportion of idle plant. Keen competition continues for export trade, to secure which manufacturers are prepared to accept substantially below the following figures, which are adhered to for home business:—Common iron bars, 12*l.*; iron rivets, 14*l.*; soft steel billets, 7*l.* 15*s.*; medium steel billets, 8*l.* 5*s.*; hard steel billets, 8*l.* 15*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates, 10*l.*; steel angles, 9*l.* 10*s.*; steel joists, 10*l.*; heavy sections of steel rails, 9*l.* 10*s.*; fishplates, 14*l.* 10*s.*; and galvanised corrugated sheets (24 gauge, in bundles), 16*l.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Conditions in the Welsh coal trade have not shown any improvement. Indeed, if anything, things have gone from bad to worse, and at present stoppages in the coalfield are numerous, because of a shortage of wagons consequent mainly on a lack of trade and the detaining of trucks under load. Colliery owners, too, have in several cases decided to close down pits and have given the men notice. The position of the trade was discussed at the annual conference of the South Wales Miners' Federation held at Cardiff during the week, and three important resolutions were adopted. The first was to the effect that the Miners' Federation of Great Britain should apply to the owners for an increase in wages from 20 per cent. above the 1914 earnings to 60 per cent.; the second, that the South Wales colliery workers should give 14 days' notice from July 10 against the employment of non-unionists; and the third, that the South Wales Coal Conciliation Board, composed of representatives of the owners and the workmen, should arrive at an arrangement to secure that coal should not be sold below an agreed figure. The first and last of these proposals are considered as impracticable by coal trade operators. They ask how is it possible under present conditions to increase the minimum wage from 20 per cent. to 60 per cent. when they cannot economically afford to pay the 20 per cent., while the proposal to fix selling prices of coal is also thought to be an absurd suggestion inasmuch as that current prices are not attracting business. With regard to the threat to strike in an effort to make non-unionists join the Miners' Federation, such action can only have the effect of diverting what orders are likely to come to South Wales to other districts. The owners' remedy for the present state of affairs is increased output and lower working costs, and to achieve this it is considered necessary that the men should revert to the 8-hours' working day and so increase output and lessen the costs of production. By this means it is felt that industries could be supplied with coal at lower prices and that this would materially help to bring about a revival in trade. Illustrations of the difficulties under which colliery owners are carrying on are afforded by the recent reports of the Imperial Navigation Coal Company and Locket's Merthyr Collieries (1894), Limited. The latter company in the eleven months ended February last sustained a trading loss of 74,887*l.*, compared with a profit of 56,943*l.* in the previous thirteen months, while the Imperial Navigation Company sustained a trading loss of 10,088*l.* in the year ended December last, compared with a profit of 30,645*l.* in the preceding twelve months.

The Iron and Steel Trades.—Though prices generally are steady, and buying is on a fairly good scale, a large number of mills are still idle. There is thus a considerable amount of unemployment, and while deploring this, makers state that the margin of profit is not sufficient to enable them to re-start the idle mills. For standard size boxes, Welsh tin-plates are from 19*s.* 6*d.* to 19*s.* 9*d.* for prompt delivery, with small concessions possible for autumn delivery. Shipments of black plates from South Wales last week amounted to 864½ tons, compared with 1,019 tons in the previous week; tin plates, 4,369 tons, against 10,833½ tons; galvanised sheets, 2,407 tons, against 784 tons; and iron and steel, 853 tons, against 8,429 tons.

THE ALBERT MEDAL OF THE ROYAL SOCIETY OF ARTS.—The Council of the Royal Society of Arts attended at Clarence House, St. James's, on the morning of June 29, at eleven o'clock, when His Royal Highness the Duke of Connaught and Strathearn, President of the Society, presented the Albert Medal of the Society for the present year to Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., "in recognition of his important contributions, both theoretical and practical, to the development of the Internal-Combustion Engine."

NOTICE OF MEETING.

THE INSTITUTION OF NAVAL ARCHITECTS.—Summer Meeting, Paris, July 4 to 8, in the Grand Amphitheatre of the Sorbonne, Rue des Ecoles, Boulevard St. Michel. The following papers will be read and discussed: "The Tendency of Warship Design as Affected by the War," by Sir Eustace T. d'Eyncourt, K.C.B., D.Sc., F.R.S.; "Some of the Consequences of the Washington Conference with Regard to Naval Construction," by Major L. Fea; "Stability of Large Ships," by Sir John H. Biles, K.C.I.E., LL.D., D.Sc.; "Some Points of Interest in Connection with the Testing of Materials for Shipbuilding," by Professor L. Guillet; "Further Experiments on Contrary Turning Co-axial Propeller Screws," by General G. Rota; "Proportions and Block Coefficient of Merchant Steamers," by Mr. W. J. Lovett. Wednesday evening, July 5, at 7.30 p.m.: Institution dinner in the Hotel Continental. Visits to various works.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—While the outlook in the Scottish steel trade is much better than it was, there is still very little doing, and the return of the members of the engineering unions to work has not yet resulted in any noticeable increase in business. That, however, will come along in due course, but it will be after the annual holidays next month before we can hope for any improvement in trade. Meantime the rolling mills are not turning out much material, this being largely due to the extreme quietness in the shipbuilding industry. Inquiries are again better, but there is difficulty in managing to get buyers to place contracts. The recent reduction in prices was expected to stimulate business, but up to date the results have been disappointing. In the black sheet trade a very quiet tone prevails, and were it not for some orders for the lighter gauges conditions would be very bad. There is very little business passing in the heavier gauges and competition is exceedingly keen. Export orders for all kinds of steel material are poor. The following are the current quotations:—Boiler plates, 13*l.* 10*s.* per ton; ship plates, 10*l.* per ton; sections, 9*l.* 10*s.* per ton; sheets, ¼ in. to $\frac{7}{16}$ in., 10*l.* 15*s.* per ton; $\frac{7}{16}$ in. to ½ in., 11*l.* 5*s.* per ton; ½ to 16 G, 12*l.* 10*s.* per ton; 16 to 20 G, 13*l.* 5*s.* per ton; 20 to 24 G, 13*l.* 15*s.* per ton; and 24 to 27 G, 14*l.* 15*s.* per ton.

Malleable Iron Trade.—The state of the malleable iron trade of the West of Scotland is far from satisfactory at the present time and employment is very bad. Home consumption is very small, and until the general trade of the country picks up a bit the outlook will continue gloomy. On the export side there is also next to nothing doing, and although there are a few inquiries in the market the actual volume represented is not heavy. Prices are unchanged with "crown" bars called 11*l.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—A healthier tone prevails in the Scottish pig-iron trade this week, and all prices show a firmer tendency. Inquiries are more satisfactory and bookings, although somewhat limited, are better. The relighting of a few more furnaces is under consideration at present, but the actual volume of orders hardly justifies much change in that direction meantime, but after the Glasgow Fair Holidays in July it is anticipated that the output will require to be increased. Prices are round the following:—Scottish hematite, 5*l.* 8*s.* 9*d.* per ton, delivered at the steel works; foundry iron, No. 1, 5*l.* 0*s.* 6*d.* per ton, and No. 3, 4*l.* 15*s.* per ton, both on trucks at makers' works.

General Trade.—Although the general trade of the country has not made any great advance a more hopeful feeling prevails, and in a few industries there has been some improvement. In the West of Scotland, shipbuilding has about the largest say in local prosperity and, unfortunately, the majority of the yards on the Clyde are extremely quiet as no new contracts have been given out for a long time back. Orders were recently received to continue the construction of certain vessels which had been stopped owing to labour troubles and high cost of construction, and orders to carry on with some of the other vessels which were also stopped are anticipated in the near future. Various contracts of one sort and another are being given out now that labour troubles are getting more settled, and among these mention may be made here of one secured by the Hamilton Wagon Company. That one is for the construction of 250 mineral wagons, each of 16 tons weight, for the Caledonian Railway Company. Another one recently fixed up by Messrs. Hugh Symington and Sons, Limited, railway contractors, Glasgow, is for the construction of a railway about 2½ miles long for the Great Northern Railway, London. This contract will take about eighteen months to complete, and is in connection with the opening up of a large colliery near Doncaster. It will leave the Great Northern main line about 7 miles south of Doncaster and run to Harworth.

ROYAL METEOROLOGICAL SOCIETY.—A summer meeting of this society will be held at the Croydon Aerodrome on Wednesday, July 5, by permission of the Air Ministry. The proceedings at the aerodrome will begin at 3 p.m. in the "recreation room," with a short address by the meteorological officer at the aerodrome, Mr. G. R. Hay, M.A., who will describe the arrangements for supplying meteorological information to pilots.

EXPERIMENTAL SHIP WITH VANE WHEELS.

CONSTRUCTED BY MESSRS. WILLIAM DENNY AND BROTHERS, LIMITED, DUMBARTON.

(*For Description, see Page* 822.)

FIG. 1.

FIG. 2

SOCIETY OF GLASS TECHNOLOGY.

THE members of the Society of Glass Technology, who met at the University of Sheffield, on Wednesday, June 21, under the presidency of Professor W. E. S. Turner, were disappointed to learn that the American Ceramic Society had decided to postpone their visit to this country until next year. The members of the society had been expected to spend three or four weeks in this country in September, and a draft programme had already been prepared of visits to various glass and pottery centres. In view of the postponement, the society decided to re-issue their invitation for next year, and also to approach the British Ceramic Society with the suggestion that that body should join in the invitation and arrangements.

Various interesting questions concerning glass-making were discussed at the meeting. A paper was received from a Japanese member, Mr. Y. Amenomiya, on "*The Devitrification caused upon the Surface of Sheet Glass by Heat.*" The glass referred to is that used for windows, and it is known that heat causes devitrification, or crystallisation. The object of the tests described in the paper was to find the temperature at which this alteration took place, and it was discovered that the danger region was from 700 deg. to 800 deg. C.

Two papers were read by students of the Department of Glass Technology on research work they had carried out under the direction of Professor Turner. Mr. K. Kamita gave an account of the work he had done on the influence of alumina in preventing the devitrification of sheet glass during the drawing process. From seven melts of a standard glass to which had been added various quantities of alumina, he showed that as the amount of alumina in the glass increased so the temperature at which devitrification occurred was raised; 5 per cent. of alumina causing a rise of approximately 100 deg. C., in the temperature at which devitrification commenced.

Mr. L. E. Norton gave an account of the work he had done on the swelling of sand on the addition of water. This matter was of importance, because many glass manufacturers still have their batch materials measured out instead of having them weighed out. Three typical sands were used in the experiments, and it was shown that in each case the addition of water caused such a swelling in the sand that the moist sand would more than fill a vessel which would hold the same sand when dry. This excess sand may be as much as 12 per cent. or 15 per cent. of the total dry sand. In each of the three cases there appeared to be a maximum amount of swelling when about 5 per cent. or 6 per cent. of water was mixed in with the sand.

Professor Turner gave a short paper on the mixing of batch, in which he compared the efficiency of hand mixing with mixing by machine. Taking three samples from a batch mixed in the ordinary way by hand, he found the maximum variations were from 44 per cent. to 77 per cent. sand and 4·8 per cent. to 8·3 per cent. lime, while a somewhat similar batch mixed by machine showed variations of from 69 per cent. to 73 per cent. sand and 4·2 per cent. to 6·6 per cent. lime. Machine mixing, by giving a much more regular batch, assisted the melting, and materially reduced the time necessary for the production of good glass. An interesting discussion followed each of the papers. During the morning a party of members visited the new works of the department at Darnall-road, Sheffield. It was pointed out that this was the last meeting of the present session.

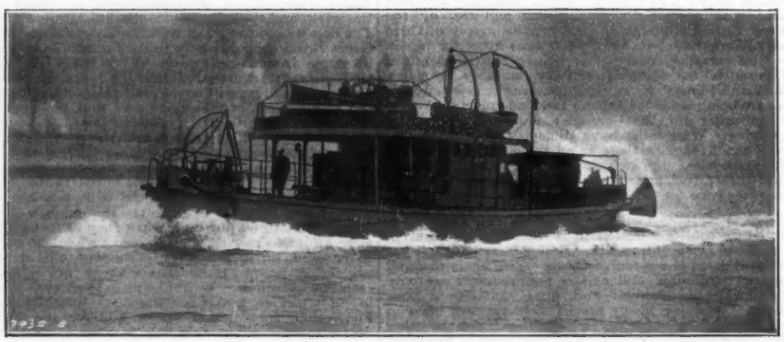


FIG. 3.

FIG. 4.

The new session will open in October, when the society will probably visit York, to inspect the wonderful stained glass in the Minster.

LEEDS PROFESSORSHIP OF CIVIL AND MECHANICAL ENGINEERING.—The Council of the University of Leeds has appointed Dr. W. T. David, M.A., Cambridge, D.Sc., Wales, to be Professor of Civil and Mechanical Engineering, and to take up his duties next October on Professor Goodman's retirement from the chair. Dr. David, who is at present Professor of Engineering at the University College of South Wales, was educated at University College, Cardiff, and Trinity College, Cambridge. He served as demonstrator in engineering under Professor Bertram Hopkinson at Cambridge, for two years, and acted as assistant gas engine designer at Messrs. Mather and Platts, Limited, for one year, after which he was appointed H.M. Inspector of Technical Colleges under the Board of Education. During the war he served as Inspector of Gun Ammunition Filling, being mentioned in despatches and gazetted Major, General List, Inspection and Research Staff. He was afterwards appointed Director of Dilution of Munitions Labour, being subsequently transferred to the Admiralty to take charge of Dilution in Shipyards and Marine Engineering establishments. In his research work he has specialised on internal combustion engines, and has contributed a number of papers to the Royal Society and to the scientific periodicals.

ENGINEERING.

Offices for Publication and Advertisements 35 and 36, Bedford Street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£3 5 0
For Canada—	
Thin paper copies	£2 18 6
Thick paper copies	£3 3 0
For all other places abroad—	
Thin paper copies	£3 3 0
Thick paper copies	£3 7 6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch, The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C. 2.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels: E. F. Satchell, 86, Rue de Tabellion.

CANADA, Toronto, Ont.: Wm. Dawson and Sons, Limited, 87, Queen Street, East.

EDINBURGH: John Menzies and Co., 12, Hanover-street.

FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Agence Havas, 8, Place de la Bourse.

GLASGOW: William Love.

INDIA, Calcutta: Thacker, Spink and Co., Bombay; Thacker and Co., Limited.

ITALY: U. Hoepli, Milan.
Anonima Libraria Italiana, Torino.
And any post office.

LIVERPOOL: Mrs. Taylor, Landing Stages.

MANCHESTER: John Heywood, 143, Deansgate.

NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM: H. A. Kramer and Son.

SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Wm. Dawson and Sons (South Africa Limited, 29 and 31, Long-street, Capetown.

TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.

UNITED STATES: For Subscription, New York: W. H. Wiley, 432, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church-street, New York.

CONTENTS.

	PAGE
The Belliss and Morcom Steam Turbines (*Illus.*)	803
The Institution of Mechanical Engineers	806
The Institution of Gas Engineers	808
International Foundry Trades Exhibition at Birmingham (*Illus.*)	809
Ship Sidelights (*Illus.*)	814
The Watson Dynamometer (*Illus.*)	814
Industrial Notes	816
Notes from South Yorkshire	817
Notes from Cleveland and the Northern Counties	817
Notes from the North	817
Notes from the South-West	817
Notice of Meeting	817
Society of Glass Technology	818
Train Control	819
Keyless Clock Patents	820
The National Physical Laboratory	820
The Institution of British Foundrymen	821
Vane Wheel Propulsion of Ships (*Illus.*)	822
Notes	823
Notes on New Books	824
Letters to the Editor.—"The Elastic Limit," "The International Exchange of Railway Data," "Developments in the Use of Paraffin for Coast Lighting"	826
Royal Meteorological Society	826
The "Aquatole" Endless-Chain Pump (*Illus.*)	827
The Simplon Universal Drafting Machine (*Illus.*)	828
Mechanical Design of Scientific Instruments (*Illus.*)	828
The Effect of Temperature on Some of the Properties of Metals (*Illus.*)	829
The Supersaturated Condition as shown by Nozzle Flow (*Illus.*)	832
ENGINEERING Patent Record (*Illus.*)	836

Two-Page Plate.—10,000-*KW. STEAM TURBINE FOR THE WEST HAM CORPORATION.*

ENGINEERING.

FRIDAY, JUNE 30, 1922.

TRAIN CONTROL.

ALL who follow railway matters are aware of the attention which has been given to automatic and other forms of train control and cab signalling in recent years. It is many years since our Board of Trade inspectors began to urge the necessity for its introduction, and with time their views have not weakened. Both in France and in the United States official opinion has likewise clearly set in the direction of its ultimate adoption in a less or more complete form. Since the war, in spite of the difficulties all railways are facing, it has been thought fitting to press for more definite action. Thus in France a ministerial circular in 1919 required the adoption of cab-signalling, with the temporary intermediate employment of certain permitted expedients. In the United States the Inter-State Commerce Commission issued in January last a circular ordering a much more comprehensive scheme of automatic train control for a complete passenger division on no less than 49 railways. This rather extraordinary order, like that in France, appears to have been prompted by the official view that the railways had been dilatory in the tests which they considered it necessary to carry out before committing themselves to a particular device. In the case of 46 of the 49 companies the order in the United States would have involved the equipment of 6,126 route miles or 10,285 track miles of railway, and no less than 5,525 locomotives, at an expenditure, of course, of many millions of dollars.

The complexity of the subject may be gauged by the divergence of even official opinion in France and the United States, and in turn with that expressed in the report, issued last week, of the committee appointed in 1919 by the Ministry of Transport. In France it is not at any rate at present intended to carry the matter further than cab-signalling, relying on the driver to take the action necessary upon receipt of an indication. The French view was expressed recently at the Railway Congress at Rome when the disadvantages of visual repetition, and the undesirability of automatic stops, were insisted upon. France is thus in a class apart from this country and the United States. In the latter it is sought to impose complete control both as regards stops and also as regards speed, while in the report just issued here the recommendation is made of automatic control at stop signals, and audible cab-signalling with brake action for warning signals. The report does not recommend speed control and advises localised instead of continuous installations.

The whole argument for or against automatic train control must ultimately rest upon the frequency of those accidents primarily due to the failure of enginemen to observe or obey signal indications. Such accidents result directly in a certain cost to the railway companies, and indirectly to the country, since financial compensation cannot actually replace lives or make good delay, and so on. There is, however, a limit beyond which the nation cannot afford to go in its precautions against accidents of any kind. The very simplest action in life is attended with risk, and while we may wish to reduce dangers to a minimum we must finally appraise them by some reference to the struggle for existence in which, nationally and individually, we are all engaged. It is unfortunately impossible for us either to evaluate the real cost of these railway accidents to the country, or to state a figure for the direct cost to the companies, either here or in the United States, as the only available statistics are incomplete. In any case owing to the different conditions of working in the two countries the same line of argument does not necessarily apply to both. In the United States it is quite reasonably being argued that instead of expending a great deal of money on the somewhat premature equipment of certain selected lengths of the railways with automatic control, the money would be far better laid out in extending the mileage worked by block signalling. The latter has proved its value in railway operation, and it would seem to be better to endeavour to raise the general degree of security than to obtain an extra high standard on one stretch of a system.

The Inter-State Commerce Commission's order, it is likewise held, goes much further than is necessary at the moment. The number of promising systems of control is limited, yet 49 railways are to equip themselves. Clearly the result will be a great deal of duplication, and it is held that rather than throw money away like this, the better control systems might be tried out exhaustively on a few railways first, before being forced upon all. The Commission, on the other hand, holds that the experimental stage is past—a view certainly not held by the majority of the railways.

With regard to this country the committee appointed by the Ministry of Transport, considers that a *prima facie* case has been made out for supplementing ordinary signalling methods by means of automatic train control as the only means of obtaining greater security against accidents due to failure of the engine men. The case is built up on statistics which are given in some detail in the report, and which, somewhat rounded off, formed the basis of the paper read by Colonel J. W. Pringle before the recent Transport Congress in London. An analysis of ten years' figures suggests in the minds of the committee that 29 per cent. of the accidents investigated would have been preventible by control. The figure is equivalent to an average of 5·6 per annum, and does not include accidents due to excessive speed or buffer stop collisions. The former are actually very few in number, while the latter are not usually preventible in the ordinary sense by speed control. Neither, of course, does the figure include the large number of minor accidents not investigated.

This average of, let us say, six accidents per annum—serious or otherwise as the case may be—may possibly be reduced according to the committee's case by an expenditure of rather more than 4½ millions sterling, coupled with an annual charge for maintenance of about 400,000*l.* The introduction of train control on the lines suggested would, it is thought, lead to a reduction in the expenditure on fog signalling, amounting to about 100,000*l.*, so that the net additional cost might run out at 300,000*l.* However, as money has to be found indirectly to cover the interest on capital cost of the installation this figure would be increased to between 500,000*l.* and 600,000*l.* annually. It is very difficult to believe that this amount, as an annually recurring charge, does not far exceed the loss to the country of such accidents as occur

under the present system in the category we are now concerned with.

The system of control suggested by this committee comprises automatic stops at stop signals, audible cab-signalling with brake application for warning signals at danger, and audible cab-signalling alone for warning signals at clear. In view of the range of conditions to be met, such as gradients, weight and speed of trains, braking power, &c., it is impossible to obtain sufficient security in general, in the committee's opinion, without train control at distant as well as at stop signals. The complete estimate therefore covers this, but the committee asserts its opinion of the higher value of control at stop signals, in spite of a large volume of opinion in this country which has always considered the repetition in the cab of distant signal indications, of the greater importance. If train control were limited to automatic action at stop signals, the estimated capital cost involved is brought down to 1,295,000*l.*, and the annual maintenance charge to 105,750*l.* It would not be unreasonable to suggest, therefore, in these days when heavy expenditure is difficult to arrange, that a start might be made with the stop signals only, putting up for the time being with the risks due to this partial application, such as they may be. On the other hand, it may be contended, of course, that it is just at places where clearing space is insufficient, &c., that distant signal indications would be more valuable. Thus if the principle is introduced, it may have to be worked out gradually on the merits of each particular case, probably, on the score of economy, with a preference for the stop control.

Hitherto experiments on a large scale in this country have concerned distant signal indications, owing to the stress laid upon the desirability of introducing nothing which might tend to make the engine men less alert. With this risk has to be considered the mechanical reliability of any appliance adopted; this must be high or the last state will be worse than the first. Although the committee considers that the reliability of control methods has been demonstrated, if we judged correctly, British opinion was not satisfied with the reports made at Rome of failures on the Continent, and probably further trials will be necessary before automatic stops are adopted in general service here under severe conditions. There are questions of standards also to consider, so that it is to be hoped the Ministry of Transport will not be too hasty in following in this matter the lead it has so often taken from the United States, and that any step which may be taken will allow ample time for the necessary investigation and experimental work. The fact that the railways are grouped in a sense simplifies the task of arriving at a decision, but combined working is in an early stage at present, and as a matter of fact gives all the more point to the necessity of care in deciding on standards in such a case as this.

KEYLESS CLOCK PATENTS.

An action recently decided and just officially reported in the Reports on Patent Cases relating to clocks of the gravity type contains some important information and several features of interest to mechanical inventors. The action was brought on two patents which overlapped in point of time. The first related to a gravity clock in which the driving pinion of the clockwork engaged a vertical rack down which the clock in working falls, the special feature being the addition of a weight to the clock, the clock together with the weight being so balanced and guided that substantially the entire weight of the clock with its supplementary weight should act at the point of contact of the pinion on the vertical rack.

The second patent covered a clock of this kind in which the additional weight was so disposed that the centre of gravity of the weight and the clock as a whole should be substantially in the same plane as the driving pinion for the clockwork mechanism and the vertical rack. Infringement was practically admitted, but the patents were both held invalid, having regard to the state of the art. The decision being given in a Court of First Instance is subject to an appeal to the Court of Appeal and also to the House of Lords. The defendants brought to the notice of the court prior patents as evidence of the state of the art. According to the learned judge gravity as the motive power of clocks by means of suspended weights is, of course, in everyday use. The prior specifications make clear that the idea of employing the weight of a clock to drive its own mechanism through a driving pinion with a vertical rack was also familiar. A clock of this kind operated by a cord instead of a rack is described in Newton's specification of 1846. Gravitation alarums of similar character are to be found in Allison's patent of 1891 and in a United States patent to Spalding of 1906. A magazine of 1894 was produced to show a clock with ordinary dial face driven by its own weight in the course of its descent along a metal rack. That being the state of the art, it was suggested that the elements of invention in the plaintiffs' first patent fell under three heads; the first being the recognition of the fact that the weight of a clock may not be sufficiently heavy in itself to run for a reasonable time with a rack of practicable dimensions, so that additional weight is required; the second the provision for balancing and guiding the clock plus the weight so that the total weight would act at the point of contact of the driving pinion with the rack, and the third the provision for balancing and guiding independently of the rack and column.

As regards the second patent the elements of invention were said to consist first in bringing the centre of gravity of the weighted clock into the plane of the rack and driving pinion and, second, in arranging that the centre of gravity should be at a point on a vertical line passing through the point of contact between the driving pinion and the rack.

The matter was gone into very carefully with the assistance of experts, and it was said that the examination of the defendants' chief witness, which went to show that there would have been no difficulty in arriving at the proper weight of a clock operating on the principle set out, was unshaken, and was indeed corroborated in the sense that the defendants' clock was designed without any knowledge of the plaintiffs' clock. The careful evidence of the plaintiffs' main witness is also held to be not in conflict with this view, and the alleged element of invention on the part of the patentee in the plaintiffs' specification was therefore nothing more than a recognition and statement of the fundamental principle of clock design that the driving force whether gravitational or other must be sufficient after making all due allowance for friction to drive the clock at the escapement end. The direction to balance and guide the clock was held to be only recognising and insisting on an obvious addition to efficiency familiar to a clock designer. The alleged element of invention of the second patent of bringing the centre of gravity of the weighted clock into the plane of the rack and pinion was held to be merely a correction of an obvious defect.

There are three passages in the report which cannot be gone into fully, but should be noted by inventors at least as expressions of opinion by the learned judge, for they raise important points, namely: (*a*) A specification more than fifty years old was substantially admitted for discussion presumably in part having regard to the fact that clocks corresponding thereto had been seen in museums; (*b*) although two applications overlapped in point of time the complete specification of one lodged in November, but not being accepted till the following April, appeared as regards the second application lodged in the February intervening to have the same legal results as if the acceptance had taken place prior to the filing of the second application; (*c*) it was pleaded that relief could be granted under the present Acts on certain claims, even although one claim might not be upheld on the ground that there was no sufficient support for it in the specification, though the learned judge expressed doubt as to whether he should grant such relief.

THE NATIONAL PHYSICAL LABORATORY.

Visitors invited to meet the General Board of the National Physical Laboratory on Tuesday last, the 27th inst., did not see much evidence of further building operations. But some of the new buildings which were rising last year are now occupied, and the growing need of a Physics Building for the Heat, Thermometry, Radiology and Sound Divisions is strongly felt. The Sound Division has only commenced work. The physical work is now too much scattered over various rooms in different buildings, partly with inadequate facilities.

There have not been many changes in the staff. The disaster to the R. 38 killed two members of the Laboratory, engaged in the experiments of the trial trips: Mr. J. R. Pannell, only 36 years old, a highly-valued senior assistant in the Aerodynamics Department, who had done much signal original work since 1906, when he joined the Laboratory, and Mr. C. W. Duffield, a skilled observer. Mr. H. Bateman, the third member of the Laboratory staff on the R. 38, was one of the very few whose lives were spared. The resignation of Dr. J. A. Harker, F.R.S., one of the original assistants of Sir Richard Glazebrook, the first director, and subsequently Chief Assistant in the Physics Department, is another regrettable loss to the Laboratory; during the war Dr. Harker had charge of the work on nitrates production initiated by the Ministry of Munitions. Other changes in the staff will be mentioned in due course.

We are glad to notice that in the interest of the junior members of the staff, boys and girls, the director, Sir Joseph E. Petavel, F.R.S., has, with the assistance of the Middlesex County Council, arranged for continuation classes, which are held in the Laboratory and are in charge of Mr. G. L. Snaith.

The somewhat serious diminution in the test work of most divisions may be temporary, and has, indeed, already been relieved by the improvement in the industrial conditions. But some factors will remain detrimental. The war created urgent and special needs; such, for instance, as those relating to Optics and Metrology. Moreover, all clinical thermometers had to be tested; whereas now an exception is made in favour of thermometers for export, which would have to be retested in the country of destination. On the other hand, though research work for firms and individuals is now more appreciated than previously, the firms themselves are combining to investigate their particular problems.

As regards the War Department, the Laboratory work is no longer "free service" and the cost of the work done is credited to the Laboratory; but the free-service practice continues for civilian departments, including the Boards and Committees of the Research Department. Provided there be no falling-off in the work for the War Department, three-quarters of the income of the Laboratory will be received for direct services rendered, and the remainder is barely adequate for carrying out the multifarious duties for which the Laboratory was founded. There seem to be no donations to the Laboratory to be recorded this year. Yet a great deal of valuable research has been done.

We begin our comments on the work of the National Physical Laboratory in 1921 with the Engineering Department, of which Dr. T. E. Stanton, F.R.S., is superintendent. The extensions of the engineering building, a large test room of 96 ft. by 50 ft., having a 3-ton traveller over the whole bay, and a block of offices in the two-storey part of the building, have been occupied this winter, while on the north side of the bay is a laboratory for steam research. We shall have to refer to our notices of previous years; last year we briefly dealt with the work of the Engineering Department in our issue of July 1, 1921, pages 10 to 12.

Engineering. Ballistic Research. Pilot Tubes in High-Speed Air Currents. (Dr. Stanton.)—Among the researches undertaken for the Ordnance Committee on Ballistic Air Resistance is the development of a high-speed wind channel for the study of the forces and moments exerted on models of projectiles. For this purpose the air velocity must be known. For the speeds in the wind channels of aerodynamical research this velocity has, since 1902, been measured in the Laboratory by a combination of Pitot tubes and static pressure tubes; for speeds exceeding the velocity of sound that method has so far hardly been tried. Assuming that the pressure conditions at the mouth of a Pitot tube

facing the current would not much differ from those at the nose of the projectile, Rayleigh's formula for the ratio p_2/p_0 (Pitot pressure to static pressure) as depending upon the ratio u/a of the air velocity u to the velocity of sound a under the density and pressure conditions should hold. Whether the high-speed air flow should be continuous, or whether intermittent flow would suffice, is not yet definitely decided. The Bureau of Standards of Washington has continuously blown air through a 1 ft. sq. channel; but that required 3,000 kw.

Dr. Stanton finds that his calculated u/a results, determined by the intermittent-flow method, are in close agreement with the Rayleigh formula. Dr. Stanton produces the air current by means of a 50-h.p. Brotherhood compressor (supplied by the Ordnance Committee) feeding into a steel drum, 4 ft. diameter by 16 ft. long, and discharging air, at a pressure of 65 lb. per square inch, through a bifurcated flexible pipe, into a vertical gun-metal nozzle which is surrounded by a 3-in. pipe carrying the discharged air on to a meter, which gives the air flow per second. The nozzle converges to a throat of 0·5 in. diameter and opens out again to a diameter of 0·8 in. For the calibration experiments of the Pitot tubes the portion of the surrounding tube serving as an experimental channel has a length of 6 in. Through a hole in the channel wall the channel is connected with a static mercury gauge. The speed determination requires a knowledge of the temperature or density of the air, and it was first attempted to measure the temperature by thermocouples; but the friction gradually heated the thermo-junction. Dr. Stanton, hence determines the momentum of the stream filling the channel; he severs the channel at the section, where the Pitot observations are made, and measures the force required to prevent separation of the two parts of the channel. This is done by suspending from a weigh beam the T-piece closing the top of the channel; there were considerable difficulties in securing a tight joint, but they have successfully been overcome.

Quick-acting Valve.—The quick-acting valve for the momentary exposure of the projectile models to the high-speed air current, in a clear way of 3 in. diameter, has been constructed by Mr. C. Mason, of the Cambridge and Paul Instrument Company. Some work on these lines was recently done by Dobrée in France; but the valve itself was not described.

Photography of Moving Projectiles. (Messrs. R. G. C. Batson and H. J. Tapsell.)—The experimental underground range made for the study of the motion of 1-in. projectiles, discharged from a Hotchkiss gun, was noticed last year. The gallery is 7 ft. by 6 ft., 150 ft. long; the sand butt at its end has a length of 15 ft. and is divided by boarding into five sections; arrangements are made for quickly recovering the projectiles from the sand. Eight steel frames, 15 ft. apart, for holding the photographic gear and the "jump cards" project from the one side. The first experiments have been made with a muzzle velocity of 1,100 ft. per second.

Lubrication. (Mr. J. H. Hyde.)—The work on the reduction of friction by adding fatty acids to mineral oils has been continued with the aid of both the Deeley testing machine and the Daimler-Lanchester moving car tester. Bayonne oil was mixed with varying quantities of (*a*) rape oil, containing 2·44 per cent. of free fatty acid; (*b*) neutral rape oil; (*c*) rape oil fatty acids; (*d*) commercial oleic acid, and it was found that as little as 0·1 per cent. of fatty acid had a considerable effect, (*c*) being most advantageous. In case (*a*) μ was reduced from 0·132 to 0·11 by adding 2 per cent. of rape oil, which would produce an acidity of 0·05 per cent., while 0·2 per cent. of (*c*) reduced the μ to 0·087, the rape oil alone having a coefficient of 0·081. In the worm gear tests the Bayonne oil was mixed with (*d*); the oil alone gave a gear efficiency of 96 per cent., corresponding to a μ of 0·02; oil (*d*) was then added to yield an acidity of 0·2 per cent., when the gear efficiency was raised to 96·4 per cent. After cooling (*d*) was increased to raise the acidity to 2 per cent., when the gear efficiency rose to 96·6 per cent., whilst the straight rape oil itself gave an efficiency of 96·7 per cent.

Pressure Distribution and Journal Friction. (Dr. Stanton, Mr. Hyde.)—Actual measurements of the oil film separating a cylindrical journal and its bearing have rarely been attempted, since Beauchamp Tower observed that the oil film extended nearly over the whole area of his half bearing of 4 in. diameter. In the present experiments journals are run in brass bushings, the differences in the radii ranging from 0·001 in. up to 0·005 in.; series of holes are provided in the bushing and are connected by tubes with gauges, while the whole device is mounted for determining the friction under load. For loads up to 200 lb. per square inch, at any rate, relatively large clearance is found to be advantageous. A bearing of a radius of 1·005 in. gave, at 940 r.p.m., a friction coefficient of 0·0023, while a bearing of 1·001 in. had a coefficient of 0·0072. In how far the seizing load will be decreased by increasing the bearing radius is further being investigated.

(To be continued.)

THE INSTITUTION OF BRITISH FOUNDRYMEN.

THE members of this Institution assembled in Birmingham on Tuesday, June 20, for their nineteenth annual conference, but except for a visit to Cannon Hill Park and a council meeting in the evening no formal proceedings took place on that day. The conference was formally opened at 9.45 a.m. on Wednesday, the 21st inst., in the large Assembly Hall of the Birmingham Chamber of Commerce when the delegates were officially welcomed to the city by the Lord Mayor, Alderman D. Davis, J.P.; the Principal of the University, Mr. S. Grant Robertson; and the President of the Chamber of Commerce, Mr. F. Hickinbotham. It was pointed out by the Lord Mayor that the Institution had had its origin in Birmingham in 1904 and had held a previous conference there in 1909. It had been granted a Royal Charter in 1921, and now numbered about 1,800 members. The retiring president, Mr. Oliver Stubbs, M.I.Mech.E., of Manchester, expressed the thanks of the Institution to the civic authorities for their welcome, and at his request the Lord Mayor handed the "Oliver Stubbs" gold medal to Mr. F. J. Cook, past-president, to whom it had been awarded by the council. The formal business of the meeting was next completed, and Mr. H. L. Reason, M.I.Mech.E., having been elected president for the ensuing year, was inducted and invested with the chain of office by Mr. Stubbs.

ELECTION OF OFFICERS AND PRESIDENTIAL ADDRESS.

The first act of the new president was to ask the retiring president to present the customary illuminated address to his predecessor, Mr. Matthew Riddell, which the recipient suitably acknowledged. The election of officers was then proceeded with, Mr. H. Jewson being elected as senior vice-president, Mr. R. O. Patterson as junior vice-president, Mr. F. W. Finch as Hon. treasurer, and Messrs. A. R. Bartlett, J. Shaw, H. Pemberton, E. H. Broughall and H. Sherburn as members of council.

The new President, Mr. Reason, then delivered his address, which was a brief one. The progress of the Institution, he stated, was very gratifying, though but for the moulders' strike and the consequent disastrous effect upon trade the increase of membership would have been considerably greater. There were over 5,000 foundries in the United Kingdom, and too many of them were still unrepresented in the Institution. Since membership had been opened to firms, two years ago, 27 firms had been enrolled. The granting of the Royal Charter had been a recognition of the importance of their work and had put them on the same plane as other leading Institutions. They were now stronger in numbers and financially than they had ever been. Their function was largely educational, and he would like to see the Institution issue a book containing accurate and useful foundry information, which should be presented to every member. It would also be a progressive step for the Institution to issue their proceedings more frequently and to supply members with a monthly bulletin. Their past president, Mr. W. Mayer, had presented gold and silver medals to be awarded alternately for Scotch and Newcastle papers to perpetuate the memory of the work of Mr. John Surtees on moulding, and the National Iron Founders' Federation had founded the Oliver Stubbs' gold medal to commemorate Mr. Stubb's name and to recognise the services of those who did meritorious work for the foundry industry.

The president concluded by referring to the work of the British Cast Iron Research Association, a body supported partly by the Department of Scientific and Industrial Research, and partly by the foundry firms, for the purpose of elucidating problems which were beyond the means of individuals. The importance of research could not be over-estimated. The problem of rusting was one of extreme importance. Sir Robert Hadfield had estimated that there was annually lost by rust 29,000,000 tons of iron and steel, which was equal to a third of the total output in 1920. The money loss was about 700,000,000*l.* a year. We could now make rustless steel, and possibly someone might find a way of making rustless cast-iron.

On the motion of Dr. Percy Longmuir, of Sheffield, a vote of thanks was passed to the president for his address, and the meeting then turned to the consideration of the papers which had been written for discussion at the conference.

SEMI-STEEL.

The first paper to be taken was one on "Semi-Steel," by Mr. J. Cameron, of the Carron Company. The author confined himself expressly to the product as made by the addition of mild steel to the pig-iron and scrap in a cupola using coke as fuel and with the usual air blast. The proportion of steel used varied from 15 per cent. for light castings to 40 per cent. for heavy castings. The practice of melting steel scrap in the ladle, as practised by some firms was bad, as the proportion of steel taken up by the molten iron was not much over 5 per cent. even under favourable conditions, and the resulting product was badly mixed and uneven in quality. Semi-steel did not displace either steel or malleable cast-iron. The steel scrap gradually became iron in passing down the cupola, and the resulting metal was a high-grade cast-iron with fewer impurities and better physical structure. Test bars showed no elongation and practically no ductility. Semi-steel was stronger than grey cast-iron under transverse, tensile, compression and impact tests. It was superior in elasticity, toughness and resistance to shock and wear. Properly made, it was close grained, homogeneous, free from hard spots, blow-holes or other defects. The graphitic carbon was finely broken up, the phosphide eutectic small, well distributed and frequently in well-defined mesh formation. Semi-steel was much superior to grey iron for machining, taking a finer polish and permitting clean-cut screw threads and clean punch impressions. It was good for such castings as cylinders, pistons and gear wheels, and other parts called upon to withstand wear and friction.

In connection with the manufacture of aerial bombs of semi-steel during the war, the author had submitted over 400 test bars to the ministry officials, and the average tensile strength of a bar cast 0·625 in. diameter by 5 in. long was over 18 tons per square inch. The average result in a bar turned from 12 in. by 1 in. by 1 in. section was 15 tons per square inch. The highest result obtained with these samples was 21·9 tons per square inch, but this was beaten by Messrs. A. Ure and Co., of Glasgow, who attained 22·9 tons from a bar cast with 50 per cent. hematite pig-iron. The Diamond Foundry Company, of Luton, had had 17 consecutive tensile tests ranging between 18 tons and 22·8 tons, with an average of 21·1 tons per square inch. Number 1 Scotch pig-iron had been found very suitable for making semi-steel, and hematite irons gave very good results. Trials of high-class irons, including cold blast, special brands and special cylinder pigs were invariably disappointing, in that no better test results could be obtained by their use.

As regards the steel scrap, mild steel boiler plate or sections used for stamping, varying in thickness from 0·375 in. upwards could be used. There were brands of mild high tensile steel and high manganese stamping steel, that gave excellent results. Steel punchings, 8 in. diameter by 1 in. thick, had been tried successfully. Borings, turnings and small punchings less than 1 in. diameter should be avoided as they led to trouble through oxidisation,

and were a frequent cause of hard spots by dropping to the bottom of the bed before being properly melted.

Some interesting results with regard to silicon in semi-steel had been noted. Test bars carrying over 3 per cent. of silicon had actually yielded a tensile strength of over 18 tons. Silicon over 2 per cent. was frequently used in heavier castings with good results. Within a wide range, the presence of silicon was harmless, but semi-steel was sensitive to phosphorus and sulphur. Cleveland iron had been tried for semi-steel, but the resulting castings were invariably brittle and low in tensile strength. Semi-steel did not owe its properties to chemical composition so much as to its physical structure, which was almost identical with that of cold blast cast-iron. In making it, everything entering the cupola must be weighed or measured, especially air. Correct gating was very essential to secure satisfactory castings, the gates and runners must be larger than for cast-iron. The metal must be melted hot and poured quickly, any delay in pouring spoiled the result as semi-steel did not retain its fluidity like grey iron. The sand should be as dry as possible as the metal was more sensitive to damp sand than was grey iron.

Experiments described in Mr. Cameron's paper, pointed definitely to the fact that the steel scrap, although placed on top of the charge in the cupola, melted before the pig. An addendum to the paper, written by Mr. J. E. Fletcher, M.I.Mech.E., gives the chemical composition suggests for semi-steel to ensure the best physical properties in cylinder hydraulic valves and fairly heavy castings. This is as follows: Total carbon, 2·8 per cent. to 3·2 per cent.; ratio of graphitic to combined carbon, 3 per cent. to 3·2 per cent.; silicon, 1 per cent. to 1·5 per cent.; manganese, 0·6 per cent. to 0·9 per cent.; phosphorus, less than 0·3 per cent. The total carbon percentage plus the silicon percentgage should vary from 4·2 for castings between 1 in. and 1·75 in. thick, to 5 for castings from 0·25 in. to 0·5 in. thick. Mr. Fletcher endorses the necessity for hot and rapid melting of the charge and considers that the amount of air used should be limited to 30,000 cub. ft. or, say, 2,300 lb. weight per ton of metal melted. The blast pressure should not exceed 8 oz. for cupolas from 24 in. to 36 in. diameter, 9 oz. for cupolas for 36 in. to 48 in. diameter, and 10 oz. for cupolas from 48 in. to 60 in. diameter. He finds that the practice of making semi-steel from a 30 per cent. or 40 per cent. steel mixture, melted down with pig-iron and scrap, and possibly a further 10 per cent. or 15 per cent. of steel scrap gives good results. Hematite pigs gave the best results in semi-steel mixtures.

The discussion was opened by M. E. V. Ronceray, of Paris, who spoke very strongly about the nature of the tests for semi-steel imposed during the war by the British and American authorities. The impact and tensile tests were stupid, for such material, for bad metal would give good results by them and *vice versâ*. The imposition of these tests had done much to keep down the quality of semi-steel. As to the effect of high silicon, he had had a silicon content up to 3·25 per cent. or 3·50 per cent. and found no harm from it. Another speaker stated that excellent results could be obtained from semi-steel containing high phosphorus. This only affected the transverse test. With 1·5 per cent. of phosphorus a tensile strength of 18 tons could be obtained and the metal was close grained and as good as lower phosphorus iron. Dr. Thomas Turner referred to the fact that semi-steel had been made eighty years ago by Stirling, who melted cast-iron and wrought iron together. He had called the product "toughened cast-iron," which seemed the most appropriate name for it. Dr. Turner, in reply to a question which had been asked, did not think that semi-steel would stand repeated meltings without its properties being impaired. The physical nature of semi-steel was the key to its characteristics. It was possible to have two materials giving the same chemical analysis but having different properties. The carbon must be in a finely-divided state in the iron if the latter was to be strong, for big flakes of graphite were a source of weakness. The total quantity of silicon in semi-steel was not a matter of primary importance, so long as a proper balance between the silicon, sulphur and phosphorous existed. Mr. F. J. Cook mentioned that he had used steel up to 40 per cent. in making semi-steel, but that increasing the proportion of steel above a certain amount reduced the tensile strength. A mixture with 15 per cent. of steel made a good metal for Diesel cylinders and castings exposed to superheated steam. Another speaker emphasised the point that the absorption of carbon by the steel took place mainly after the latter was fully melted. He had not been able to get more than 0·5 per cent. to 0·6 per cent. of carbon absorbed at the time of melting, but with a low bed of a depth equal to 12 per cent. of the diameter of the cupola, the absorption was from 1·9 per cent. to 2 per cent. With a still lower bed 2·6 per cent. had been absorbed.

The author, in his reply, remarked that to a limited extent the remelting of semi-steel might be useful, but too often repeated re-melting would result in the absorption of sulphur. The best proportions between the carbon and silicon contents and the best quantity of total carbon in relation to the thickness of the casting were subjects on which research was needed. A vote of thanks was accorded the author, and the meeting proceeded to the next paper.

American Malleable Castings.

The second paper on Tuesday was entitled "American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product," by Mr. Enrique Touceda of Albany, N.Y., U.S.A. This was a long paper and an interesting one, but of a nature very difficult to deal adequately with in an abstract. The author is regarded as one of the greatest authorities in the United States on the manufacture of malleable cast iron, and he discussed in his paper the lay-out of a plant, the ventilation, heating and lighting of the same, the use of handling appliances, the details of furnaces and annealing ovens and methods of firing. The heat treatment of malleable castings, their machining properties, and the metallurgy of the subject were also dealt with. The impression left on the mind by the paper, and much more so by the discussion, was that American malleable iron practice was far ahead of practice in this country, both as regards quality and quantity. One speaker who had recently returned from the States said the first malleable iron foundry he visited had an output of 2,000 tons of castings per week, while 60-ton and 70-ton furnaces were common. All labour-saving devices were adopted, and no man was ever seen pushing a barrow in such foundries.

Some of the test results for malleable castings, given by Mr. Touceda in his paper, were very extraordinary. In one case the tensile strength of malleable cast iron after treatment in a muffle furnace, was 26·5 tons per square inch (whether long or short tons did not transpire) the elongation was 36·7 per cent. on 2 in. and the reduction of area was 38 per cent. Other tests given were nearly as good, although the author remarked that they were all exceptional figures.

In the 5 minutes summary which he gave to his paper, Mr. Touceda called the attention of the members to two points which he regarded as of special importance. The first was the effect of inadequacy of gating on the manufacture of defective castings. He illustrated in the paper a series of castings made by "short-pouring" in similar moulds. These showed very definitely the relative difficulty the metal had in finding its way to different parts of the mould and indicated the paths the metal took. Very valuable information could be obtained from studies of this character, and the area and position of the gates could be altered in accordance with the indications, so as to secure the most even distribution of the metal. Experiments in "short-pouring" are so easy to carry out and the results are sometimes so suggestive, that the method might well be tried in many foundries, especially where much plate moulding is done.

The other point emphasised by Mr. Touceda was in connection with the effect of small quantities of chromium on the castings. He had been puzzled by certain test bars which, when broken while the metal was still warm, had shown a normal fracture, but when broken cold had given a steely fracture. The good fracture was obtained at a temperature of about 300 deg. C. In time he had discovered this kind of test-bar always showed the presence of chromium in minute quantities. Less than one-tenth of 1 per cent. of this element would produce an abnormal fracture. At atmospheric temperature the effect of chromium was to embrittle ferrite, while at a temperature of 205 deg. C. the ferrite regained its ductility.

The discussion on Mr. Touceda's paper was brief and did not bring out any points of importance.

At its conclusion a vote of thanks was accorded to the author, who was asked to reply in writing in view of the shortness of time available for the remainder of the programme.

Safety Work in Foundries.

The third paper discussed on the morning of the 21st inst. was entitled "Safety Work in Foundries," by Mr. R. W. Patmore, of the Industrial Welfare Society. It was stated in the paper that during the previous twelve months an average of three men per month had been killed in British foundries, and 5 per cent. of the foundry workers meet with accidents every year. The author proceeded to point out the evils of accidents not only to the workers but to the firm, and urged that the co-operation of the workers should be secured in eliminating accidents. The paper throughout was of a general nature, and advocated principles with which everybody would concur and which the more enlightened managements put into practice as far as possible. About the worst feature of old foundries is the lighting, and in regard to this the author confined himself to the remark that "he (the managing director) must get the best illumination possible." In the previous paper by Mr. Touceda the question of foundry lighting is considered in more detail, and it is recommended that the illumination should amount to from 3 ft-candles to 6 ft.-candles, corresponding, in the case of electric lighting, to a power requirement of 0·5 watt to 1 watt per square foot of floor area, depending on the class of work being done. This, it is remarked, is double the minimum required by the New York State Industrial Commission. After passing a vote of thanks to the author of the paper the meeting was adjourned till Thursday, the 22nd inst.

(To be continued.)

VANE WHEEL PROPULSION OF SHIPS.

The need for shallow-draught in ships produces a series of difficulties to the effective use of the engine power of a ship, and it is therefore not surprising that the question has received the attention of a large number of inventors. Completely immersed propellers if used in vessels of small draught must of necessity be of small dimensions and therefore of low propulsion efficiency. Naval architects have previously used one or other of three different types of gear. The first is the use of tunnels in the stern of the vessel enclosing the screw propeller. In this way larger propellers may be employed, and they are completely covered with water when the boat is running at full speed, which may be obtained with a fast-running engine. The other equipments are side paddle wheels and stern wheels, each of which provide a more efficient utilisation of the engine power than the tunnel system. Paddle wheels give a higher efficiency than screw propellers but have all the disadvantages that are associated with the low-speed of running, much greater overall breadth of ship and the liability of damage to the wheel. The engine speed being low, the engine must be very heavy for any power requirement. The propulsive efficiency of the stern wheel is higher than that of either the screw propeller or paddle wheel, but this method has the disadvantages associated with greater overall length of ship and wheels, and there is also greater liability to damage stern wheels than screw propellers. Water jet propulsion and air screw propellers have been adopted in special cases where low propulsion efficiency is not regarded as a serious disadvantage.

Messrs. William Denny and Brothers, of Dumbarton, have introduced a new solution to the problem of efficient propulsion with shallow draught, by the introduction of what they term "vane wheels." Vane wheels are partly immersed wheels having their axes above water and usually in the line of advance. They are fitted with propelling vanes

EXPERIMENTAL SHIP WITH VANE WHEELS.

CONSTRUCTED BY MESSRS. WILLIAM DENNY AND BROTHERS, LIMITED, DUMBARTON.

FIG. 5.

over the immersible circumferential portion, the vanes having a pitch so that when the wheels are rotated they exert a forward thrust on the vessel. On the experimental boat, which is illustrated in Figs. 1 to 4 on page 818 and Fig. 5 annexed, the vane wheels take the form of large curved plates like the tip of a propeller blade, but with straight sides, and a circular outside edge. These vanes, three in number, are each riveted to two arms, which are part of the hub. In order to avoid any undesired steering effect the two vane wheels have identical dimensions and are symmetrically placed on the hull of the ship. One wheel is right-handed and the other left-handed, and they are rotated in opposite directions so that the transverse thrust of each vane is balanced by that of the other when they are driven at the same speed. These wheels are placed side by side abaft the stern of the ship or one on each side of the ship slightly forward of the stern. The tests, so far, have been limited to experiments with a boat of shallow draught, and in this case the results obtained with a vessel designed for use as a twin-screw steamer, have shown a considerable reduction in the power required for a given speed. The following table gives the test figures of experiments conducted by Messrs. Denny on this vessel:—

Length	100 ft.	
Breadth	23 ft. 6 in.	
Draught	4 ft. 5½ in. forward 4 ft. 6¾ in. mean 4 ft. 8 in. aft	
Displacement in tons ...	186	
Speed in knots	9	
	Screw Propellers.	Vane Wheels.
Diameter, in feet	4 ft.	11 ft.
Pitch, in feet	5 ft. 8 in.	16 ft.
Number of blades ...	3	3
Total disc area	25·14 sq. ft.	
Total projected area ...	10·2 sq. ft.	
Revolutions per minute ...	226	66
Total sectional area of water acted upon when at full speed	—	59·26 sq. ft.
E.H.P. of naked hull ...	77·5	77·5
Shaft horse-power ...	197	116

These test figures show that the vane wheels gave the same speed as the twin screws with 41 per cent. less shaft horse-power. It will be noted that the efficiency of the twin screws was rather low, but that the vane wheels show a value of 67 per cent., which is very high compared with that of the other alternative systems. The vane wheels have the advantage of great manœuvring power; this was ably demonstrated in the Gareloch on Tuesday of this week, before a party of engineers and naval architects. With one vane wheel running ahead and the other astern the boat could be turned about its own centre. When one wheel is in operation and the other stationary the manœuvring capabilities are those of a twin screw steamer at its best. During the demonstration the vane wheels were driven through belts from two 100-h.p. Sulzer engines, made by Messrs. Denny. This belt drive is only contemplated of course for use on the experimental installation. During the demonstration the slip of the belt prevented the boat being driven by the full power of the engine. An explanation of the high propulsive efficiency of the vane wheels is found in the fact that the hubs of the vane wheels are out of the water, and therefore involve no extra resistance as is the case with ordinary screw propellers, and also that they do not require any immersed supports such as bosses or brackets.

NOTES.

THE INSTITUTION OF ELECTRICAL ENGINEERS' WAR MEMORIAL.

IT is right that engineers, as well as others, should hold in remembrance those of their colleagues who fell in the Great War, and in no more fitting way can this be ensured than by setting their names in the headquarters of the engineering institutions of which they were members. This is a seemly act and honours the institution which carries it out as well as those whom it commemorates in pride and thankfulness. More than one engineering memorial has been unveiled in the past, and the number was added to on Wednesday last when the war memorial in memory of the members of the Institution of Electrical Engineers who fell in the Great War was dedicated by the Right Rev. Bishop Ryle, Dean of Westminster, and was unveiled by Air Chief Marshal Sir H. M. Trenchard, who was supported by the President, Mr. J. S. Highfield, and the senior Vice-President, Dr. W. H. Eccles. A simple and impressive ceremony had been arranged which opened with the hymn "O God, Our Help in Ages Past," the dedication and unveiling being followed by the sounding of the "Last Post" and the "Reveille." The proceedings terminated with the National Anthem. The music was performed by a section of the band of the Royal Engineers from Chatham, and the singing was led by choristers of H.M. Chapel Royal, Savoy, under the direction of Dr. Bromley Derry. The memorial takes the form of two bronze plaques set in the walls of the entrance hall of the Institution building. They carry the names of 162 members who lost their lives on active service. In all over 2,000 members of the Institution of Electrical Engineers, nearly one-third of the membership at that time, were on active service in the war.

THE SUKKUR BARRAGE PROJECT.

On Friday last, Mr. F. W. Woods, C.I.E., late chief engineer, Irrigation Department of the Punjab, read a paper before the Royal Society of Arts, entitled "Irrigation Enterprise in India." Although there are several important schemes afoot in connection with irrigation in India, Mr. Woods practically confined his attention to the much-debated Sukkur Barrage project, which he condemned. In his opening remarks the author reviewed the history of British irrigation enterprise in India and showed that several ill-designed schemes had been converted by degrees and slow development into successful enterprises so that some of them were paying a very good return on the capital invested. From this Mr. Woods passed to a consideration of the probability of success of the Sukkur scheme, the cost of which is estimated at about 12,300,000*l.*—a figure said by many engineers to be greatly underestimated. At the same time Mr. Woods argues that the official estimates of the effect of the scheme are far too optimistic, and that the increased area which it will be possible to bring under cultivation has been exaggerated. The project relies largely upon extending the winter irrigation of certain tracts, but these forecasts are unjustified by past experience. Mr. Woods arrives at the conclusion that the project will ultimately show a return of only 2·7 per cent., or about 68 lakhs of rupees less per annum than the interest on the borrowed capital. He also considers that the effects of waterlogging have not been sufficiently considered, nor the effect of the proposed barrage on the silting-up of the bed of the river itself above the Sukkur Gorge, and of the canals. The present project has, as is known, also been criticised by Dr. Summers, late chief irrigation engineer, Sind, who suggested that construction of the barrage should be deferred till the Rohri Canal works had been taken in hand. Mr. Woods proposes cutting out the barrage scheme altogether and arranging to irrigate annually about 1,800,000 acres, half in each season, using a head regulator only at the off-take at the Rohri Canal.

THE REGULATION OF THE RIVER RHINE.

In its upper reaches the Rhine is a swift-flowing river, and in many parts offers serious obstacles to navigation, and much discussion has centred on plans for regulating or improving it in some way. The reach between Strasburg and Basle has particularly been the subject of attention. This stretch of the river is, in the words of M. A. Antoine, who read a paper before the British Section of the Société des Ingénieurs Civils de France on Monday last, "a semi-torrential stream, that erodes its bed and is constantly changing its place amidst gravel banks between the two embankments, built up to protect against its ravages the neighbouring country." The navigable period of the year over this portion of the river is very short, and owing to the strength of the current the large paddle tugs which are used can only tow a single 1,000-ton barge about half loaded at some 4 m.p.h. The journey from Strasburg to Basle usually occupies three days. The improvement of this part of the river would be of great importance both to France and Germany, while Switzerland is also closely interested, as she would obtain direct access to the sea by a great inland waterway. In general, French and German opinion has favoured the construction of a canal more or less parallel to the river, while in Switzerland the dredging and regulation of the river itself has been favoured. The paper by M. Antoine, to which we have referred, gave an excellent account of the whole subject, and made a good case for a canal on the French side of the river in Alsace. The fall from Basle to Strasburg is some 125 m., and the plan for the canal includes hydro-electric stations at the various locks. We have referred to this subject more than once in the past,

and to the differences of opinion existing in France and Switzerland on the subject, and it was of great interest to note that M. Antoine thought Swiss opinion, and particularly Swiss technical opinion, was tending to come into line with that of France. By the Treaty of Versailles France has the right to take from the Rhine the water necessary for the proposed canal and has the exclusive right to the energy that may be developed, subject to paying Germany half the value of the energy actually developed. M. Antoine stated that the canal would take twenty years to build.

THE BECKTON GAS WORKS.

The Beckton Gas Works, which, as mentioned on page 809 of this issue, were visited on Friday, the 23rd inst., by the members of the Institution of Gas Engineers, are situated on the Thames, immediately east of the Royal Albert Docks, and have a river frontage of about 2,500 ft. Gas was first supplied from Beckton in 1870, and the production has developed since then to such an extent that of the 33,444,000,000 cub. ft. manufactured by the Gas Light and Coke Company last year, nearly a half, or 15,785,000,000 cub. ft., to be exact, was supplied from Beckton. The greater part of the coal used is delivered by steam colliers of from 1,000 tons to 4,500 tons, and is unloaded at the upper of two T-shaped piers by means of hydraulic cranes. The other pier is used mainly for the loading in craft of coke, pitch, sulphate of ammonia and other residuals. The maximum quantity of coal unloaded during any year was reached in 1913, the figure for that year being 1,528,000 tons. There are 14 retort houses, each of which constitutes the nucleus of a complete gas works, having its own exhausting, condensing, purifying and measuring apparatus. The houses contain, in all, 4,146 horizontal retorts, all of which are 20 ft. in length, except those in the recently reconstructed No. 7 retort house, which are 23 ft. long. Two retort houses are operated by Fiddes-Aldridge stoking machines, five with West's machines fitted with De Brouwer projector type chargers, four with Arrol-Foulis machinery, and the remainder with Drake's machines. All except three houses are fitted with mechanical appliances for handling coke. In addition to the coal gas plant, which has a total daily production capacity of 66,000,000 cub. ft., there is a carburetted water gas plant, which, with two blue-gas sets, is capable of producing a further 27,000,000 cub. ft. daily, bringing the total daily capacity of the whole works up to 93,000,000 cub. ft. The gas produced is supplied to the company's distribution area through two 48-in. mains, its pressure being increased to 48 in. water column in two pumping houses. The present capacity of one of these houses, with four pairs of exhausters, is 2,800,000 cub. ft. per hour, but two sets of Reavell's turbo blowers, with a combined capacity of 3,000,000 cub. ft. per hour, have recently been installed, and it is proposed to duplicate these blowers in the near future. The new turbo blowers have been designed to pump against a pressure of 80 in. water column, and the combined capacity of three sets of these will be adequate for the normal winter load. The works include electric generating stations driven by gas and steam engines aggregating 1,630 h.p., and there are extensive machine shops, repair shops, &c., for the upkeep of the plant. Reference to some of the recent reconstruction work at Beckton will be found on page 809 of this issue.

THE INSTITUTION OF MINING ENGINEERS.

The seventy-seventh general meeting of the Institution of Mining Engineers was held in Sheffield on Tuesday, Wednesday and Thursday, 20th to 22nd inst. The members were welcomed by the Deputy Lord Mayor (Alderman W. F. Wardley), representing the Lord Mayor (Alderman C. Simpson), who was unable to be present. The first paper read was one on "Stainless Steels," by Dr. W. H. Hatfield, who stated that many items could usefully and economically be manufactured of stainless steel, such as boiler fittings, pump rods, pump cylinder liners, valve component parts, whether for steam, water or air, impeller blades, the component parts of coal conveyors, weighing machines, amongst numerous others. Although they were costly, wire ropes made of stainless steel had certainly a definite application under certain conditions. To his knowledge, ropes of stainless steel had not yet been manufactured commercially; specimens of such ropes could, however, be seen at the Brown-Firth Research Laboratories, which, it could be ascertained, were quite excellent. Springs were being manufactured successfully of stainless steel. In regard to the discovery of stainless steel, this was due to Mr. Harry Brearley, who made it in the year 1913. The second paper was by Mr. Eric Davies; it described the "Air-Cooling Plant of the Morro Velho Mine, St. John del Rey Mining Company, Limited, Brazil." This, it was explained, was comparable to the refrigerating installation of a cold-storage plant. It allowed of safe working in the mine from the temperature point of view, and the general improvement in underground conditions was also reflected in various ways, two of the most striking being the reduction in the accident rate, and increased output. The third paper had reference to "The Methods of Working the Barnsley Seam of the South Yorkshire Coalfield." The authors, Messrs. H. and M. Rhodes, explained the different methods of working which had been adopted in the Barnsley seam since the earliest period, and stated that the Yorkshire output this year would be in the neighbourhood of 40,000,000 tons, 30 per cent. of which came out of that seam. They added that "if they could have a seam put in the ground to work economically, they would not make it more than 5 ft." The fourth paper was on "Rock-Temperatures in the Coal Measures of Great Britain," by Mr. J. Ivor Graham, of Birmingham University. It gave the results of determinations made at a large number of mines and boreholes throughout the country. The last paper dealt with "The Rate of Absorption of Poisonous Amounts of Carbon Monoxide by the Blood," and was contributed by Mr. A. P. Veale, Mining Research Laboratory, of Birmingham University. The conclusion drawn from experiments by the author, and by others, one group of experiments being with men whilst resting and one whilst working, was to the effect that no one should ever go into a suspected atmosphere unless accompanied by a small, warm-blooded animal. During their stay, the members visited a number of works and mines in Sheffield, and in the neighbouring district.

CONVERSAZIONE OF THE INSTITUTION OF CIVIL ENGINEERS.

The conversazione of the Institution of Civil Engineers, which was held on Tuesday last, was an interesting and enjoyable function. The attendance was large, and the programme of music provided, together with lectures, demonstrations and exhibition of engineering models and scientific apparatus were sufficient to provide continuous entertainment. The visitors were received by the president, Mr. W. B. Worthington, and Mrs. Worthington. The programme included an exhibition of lantern slides of Mount Everest by Lieutenant-Colonel Sir Francis Younghusband, and a lecture, with demonstrations, on wireless "broadcasting" by Captain H. R. Sankey. The collection of specimens illustrating the deterioration of marine structures was also open for inspection. The demands upon our space will not permit us to deal fully with the numerous exhibits, particularly as many of them have recently been described in detail in our columns. This applies particularly to the very interesting optical demonstration of the action of cutting tools by Professor E. G. Coker, the effects of alternating magnetic fields shown by Mr. W. M. Mordey, the Collins' micro-indicator exhibited by the Cambridge and Paul Instrument Company, Limited, and the "Rotascope" apparatus for rendering rotating objects apparently stationary shown by Dr. E. H. Rayner. The interesting model of one of the sluices of the Assuan dam shown by Dr. H. E. Hurst and Mr. D. A. F. Watt, has been used to examine the relation between its discharge and that of the actual sluice. With similar models of different scales, it has been shown that the relationship is such that $\frac{Q}{q} = n^{\frac{5}{2}}$, where Q and q are the discharges of the full-size and model sluices respectively, and n is the scale ratio. Of the numerous exhibits by the National Physical Laboratory we can only mention a working model of a new form of testing machine for driving chains and spur gears, which has been installed in the engineering department of the laboratory; we hope to deal more fully with this machine on a future occasion. Mr. P. V. Hoare showed a model suitable for use in colleges, &c., to illustrate the effect which alterations in the angle of incidence of an aeroplane wing have on the lift, drag, resultant force and position of centre of pressure, and another exhibit, which attracted considerable attention, was a demonstration of the working of the "Schoop" pistol. This appliance can be used for spraying a metallic coating on to practically any material for decorative purposes or for protection against corrosion. As an example of its technical applications we may mention that one of the products exhibited was a motor-car engine piston cast from an aluminium alloy and afterwards provided with a thin coating of iron. Sir Robert A. Hadfield showed a very interesting collection of examples of bullet-proof steel body shields, shrapnel helmets, and other manganese steel products, as well as of low hysteresis steel, stainless steel, and special steel for permanent magnets. Test specimens, a Guillery shock-testing machine, and an interesting collection of old metallurgical books, were also included in Sir Robert's exhibit. Mention should also be made of the Fereday-Palmer stress recorder for structures shown by Messrs. T. Cooke and Sons, Limited, of York, and of the apparatus used for obtaining records of dust particles in the air exhibited by Dr. J. S. Owens. The exhibits above referred to were all shown in the library, but in addition to these, an attractive collection of wireless apparatus by Marconi's Wireless Telegraph Company, was on view in the south reading room. Of this the most interesting item was a demonstration of the recently developed "wireless beam" method of signalling for use in connection with navigation. In the apparatus shown, waves only 90 cm. in length were reflected by a rotating parabolic mirror and picked up by a portable receiver which could be placed in any part of the room. With this system, the arrangements are such that it is possible for the receiving station to obtain the true bearing of the sending station in a very simple manner, and with reasonable accuracy. The function was in all respects a most successful one, and the staff of the Institution are to be congratulated on the admirable arrangements for marshalling and providing for the convenience of so large a number of guests.

NOTES ON NEW BOOKS.

"*The Working of Steel*" (by Fred. H. Colvin and K. A. Juthe; London: McGraw-Hill Book Company, Inc.; price 18s. net), is a book of American origin, and deals with the heat treatment of steel and the effect of composition on its properties mostly from the point of view of American practice. It contains a large amount of miscellaneous information on the subjects named, and is the type of book which may prove useful in the hands of foremen and charge hands in steel works and heat treatment plants. There is little or no explanation of phenomena given—the facts are stated baldly and every statement refers to a particular case. A chapter is devoted to the description of the steels and treatments used in the Liberty aero engine parts which will prove a useful record. A very amusing table is given summarising the effects of different elements on steel, as follows:—

The Ingredient.	Its Effect.
Iron	The basis of steel.
Carbon	The determinative.
Sulphur	A strength sapper.
Phosphorus	The weak link.
Silicon	Impurity and hardener.
Oxygen	A strength destroyer.

This indicates the style of treatment used throughout, and it will therefore be seen that the book is in the nature of a record of practical experience interpreted from a very restricted point of view. Nevertheless, it will no doubt find a circle of readers to whom it will appeal.

The extraordinary rapidity with which the commercial importance of the great Republics of South America has developed of late is appreciated by few. It was accordingly a happy idea of the Federation of British Industries in 1921 to promote the compilation of "*An Anglo-South American Handbook*," under the editorship of Mr. W. H. Koebel. The 1922 edition has just been issued by Mr. T. Fisher-Unwin, the price being 25s. net. The title is perhaps insufficiently

comprehensive since the volume deals with practically the whole of Latin America, including Central America, Mexico and Cuba. The handbook forms not only a comprehensive, commercial and financial directory, but includes useful notes on transport, taxes, and the like, as well as a short account of the geography, history, constitution and products of each of the States dealt with.

A feature in many of the text-books on technical subjects issued by American professors, who reproduce in book form their class-room and lecture notes, is the large space devoted to the preparation of specifications and forms of contract. These are matters of detail which in this country are studied by juniors in the course of actual practice, but the American aim appears to be so to train their students, that they are equipped not only to meet the problems of engineering design and construction, but are equally proficient in those details of office work which are acquired by actual contact with, and management of, affairs. Dr. H. E. Babbitt, M.S., Assistant Professor of Municipal and Sanitary Engineering in the University of Illinois, follows this practice in his treatise on "*Sewerage and Sewage Treatment*" (Wiley and Sons, New York; Chapman and Hall, London; price 25*s.* net), a generally admirable work, that has benefited, as the author admits, not a little from the unintentional criticisms of his pupils, and the searching questions his class has propounded. This treatment has had the effect of calling attention to what is obscure in teaching or demanded more adequate explanation. After an introductory chapter containing some historical matter, it is indicated that the aim of all sewage treatment should be to produce an effluent that can be disposed of without causing a nuisance, and that the simplest process by which this result can be attained is the process to be adopted. The Hydraulics of Sewers is introduced, and once again the merits and inconveniences of Kutter's well-known formula is threshed out. Some ingenious diagrams are added to aid the solution, but we suspect that experience more often determines practice than an appeal to original work. From the general conditions common to sewer construction, attention is directed to the design of special sewerage systems and the circumstances under which the separation of surface drainage from sanitary sewage and industrial waste may be feasible or desirable. Details figure largely and are of an eminently practical character, the illustrations being drawn from systems in actual use in some large towns. A chapter on pumps is added. On the material for sewers and appurtenances generally it is possible to write instructively, though difficult to say anything original, but the analysis of sewer arches, utilising the force polygon is effective and well arranged. The introduction of a chapter on contracts and specifications, on costs data and estimates, seems unfortunate, as it delays progress in the discussion of matters more closely connected with the main topic as, for example, the disposal of sewage. In this section many matters come under review that interest the public quite as much as the engineer, and the chapters on Dilution, Screening, Sedimentation and Septicization will be found more interesting than the subject seems to promise. Of particular importance is the process of self-purification in running streams. The possible advantages of septic action are fully admitted, but it is distinctly asserted that the claims made at the time of its introduction have not been realised, and occasionally the discharge of the effluent is more offensive than the influent, while over-septicization can entail great difficulties. The activated sludge method of treatment is generally viewed favourably, on account of the fertilising qualities of the product, and the promise the method offers for the recovery of nitrogen from sewage, but the cost of operation is relatively high, constant and skilled attendance are necessary, and the dewatering of the sludge may cause difficulties.

Forty years ago most engineering pocket books consisted almost wholly of mere rules and tables unaccompanied by any hint as to the limits within which they were applicable. These rules were commonly accepted as reliable under all conditions, and when failures occurred through some outrageous misapplication of them, the practical man's belief in the uselessness of theory, received a fresh accession of strength. The older type of pocket book, moreover, contained relatively little descriptive matter and few illustrations of machines and their elements. It is, nevertheless, a difficult matter to know where the line is to be drawn between a pocket book and an engineering encyclopedia. A very fair compromise seems to have been secured in Messrs. Seaton and Rounthwaite's "*Pocket Book on Marine Engineering*," of which the fifteenth edition has just been published by Messrs. Charles Griffin and Co., London, at 15*s.* net. Some drastic alterations have been made owing to the supersession of many of the old rules of the Board of Trade, Lloyd's Register, the British Corporation and the Bureau Veritas, by the new unified rules of the British Marine Engineering Design and Construction Committee. In referring to the internal-combustion engine, Mr. Seaton expresses the regret, which is shared by most of us, at the lack of enterprise and foresight shown by so many British builders of marine internal-combustion engines, who seem unwilling or unable to proceed without the help of foreign patentees and inventors. Very few, in fact, will give our own clever young men a chance. It was the same with the steam turbine, for whilst the head of one well-known Midland firm bluntly declared that he intended to build his own turbines without foreign assistance, and succeeded in doing so, others paid large sums for foreign assistance, and found in most cases that their timidity availed them nothing, as the foreigner, though more enterprising, was not materially more experienced than themselves, and strips and smashes were frequent. The present issue of the marine engine pocket book covers a very wide ground and can be recommended as exceptionally well-adapted to the needs of the drawing office.

Professor Sydney Young's volume on "Distillation Principles and Processes," which we noticed a few weeks ago, stands practically alone, as regards the technical side of its subject, among general treatises of this kind in this country and in English, but Continental workers have contributed several good books on theoretical and applied distillation within the last decade. Professor Clark Shove Robinson, of the Massachusetts Institute of Technology, was therefore—especially before the appearance of the new edition of Young's "Distillation"—amply justified in attempting, in his "*Elements of Fractional Distillation*" (New York and London: McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. Price 12*s.* 6*d.* net) to explain the principles involved in such a way as to render them applicable to particular problems. But we are not convinced that explanations gain in lucidity by being given "according to the best ideas of Physical Chemistry and Chemical Engineering," and that the acquisition of scientific knowledge is facilitated by expressions such as "There is a law of thermodynamics, known as Phase Rule." The short theoretical sections are really better, however, than one might anticipate from such phrases. We accept Professor Robinson's elements of 205 pages as "an introduction to the study of Fractional Distillation," and the author need hardly have been afraid, we should think, that his book might be regarded as "a complete treatise or an encyclopædia on the subject." Some readers might, however, have preferred at once to have the further volume promised on the general practice of fractional distillation. The chapters on Ammonia, on Benzolised Wash Oil and on Methyl and Ethyl Alcohols are rather general, and all the illustrations in the volume are mere diagrams. But the book will certainly serve a useful purpose. Mr. Robinson is assistant professor of chemical engineering at the Massachusetts Institute of Technology.

The third volume of Sir Edward Thorpe's "*Dictionary of Applied Chemistry*" deals, in its 735 pages, with the items Explosives to Kyrofin, and thus carries the dictionary a good deal further in the alphabet. We have noticed the first two volumes of this dictionary which is published by Messrs. Longmans, Green and Co., of 39, Paternoster-row, E.C. 4 (price 3*l.* net, bound). Among the contents we notice the section on Explosives by Mr. G. H. Perrin, of Woolwich Arsenal, well written, though not yet embodying the Records of Explosives Supply, 1915–18; the articles on Coal Gas, by Dr. H. G. Colman, on Fuel by Professor W. A. Bone, on Glucosides by Dr. E. F. Armstrong, on Glass by Dr. W. E. S. Turner, and on various colouring matters by Dr. A. G. Perkin. The article on Indigo is still that of the late Professor Otto N. Witt, brought up to date, and the section on Filter Pumps similarly bears the initials of the late Mr. Thomas Fairley, as several sections on some greases, fats, glycerin, bear those of the late Dr. J. Lewkowitsch. Not all the subjects are sufficiently supplemented, however, and it is unsatisfactory that one looks in vain for terms like flotation, fluorite, inhibition periods, fersan, ferratogen, galvano-technics, ironac, Kessler. One would also expect to find, in a dictionary of applied chemistry, general articles on fats, films and their manufacture, on gas filtration and on hair and hair dyes, but those items are absent.

The Empire is not well stocked with potash minerals. Potash salt deposits, we see from the new edition of "*Potash*," by Mr. Sydney G. Johnstone, B.Sc., one of the publications prepared under the direction of the Mineral Sources Committee of the Imperial Institute (London: John Murray; price 6*s.* net), occur in some parts of India, especially in the Mayo Mine, at Khewra, and at Nurpur, in the salt range of the Punjab, further at Malagash, and in Cumberland County of Nova Scotia, where lenticular potassium chloride is found in common salt. The salt lakes of Canada do not contain workable amounts of potash and differ in so far from some salt lakes of the United States; but the Lonar Lake, of Behar, India, is said to contain up to 10 per cent. of potash. The saltpetre of the old villages of India, being of organic origin, has to be considered apart from other sources. Altogether some 40,000 Indian factories are said to supply crude saltpetre; though some of these are worked by one man only, India produced in 1913 over 15,000 long tons of saltpetre, and the production rose to 25,671 long tons in 1916. Rhodesia and South Africa also yield some saltpetre. The utilisation of sea water as a source of potash has ceased to be of importance. All the potash salts so far mentioned are water-soluble. The insoluble salts, alumite (potassium-aluminium sulphate), feldspars (silicates), &c., are either used as fertiliser or the potash is extracted as a by-product. That applies more or less also to wood ash, beetroot, marine plants, wool washings, and to the recent extraction of potash from the dusts of cement kilns and the slags of blast furnaces.

The lac industry interests many trades and particularly electrical engineers, and manufacturers of varnish, furniture and sealing wax, as well as makers of hats, gramophone records and some other specialities in particular. The lac is the rosin of an insect, tachardia or coccus lacca, and shellac is the most important of the various resinous constituents of this substance which are commercially known as stick-lac, seed or grain-lac, button-lac, &c. Most of this lac comes from India, Siam and China. India, in fact, annually produces 400,000 cwt. out of a total of 425,000 cwt., and the Secretary of State for India hence invited the Imperial Institute in 1916 to report on the possibilities of further commercial uses of lac as one of the principal Indian raw materials. The "*Reports on Lac, Turpentine and Rosin*," forming one of the publications of the Indian Trade Inquiry (London: John Murray; price 5*s.* net), a pamphlet of 74 pages, deals with scientific, technical and economic features. The importance of Indian turpentine is increasing because the American production of turpentine is declining. The chief source of turpentine in India is the Chir pine which bears the same name, but differs from the American pinus longifolia, now designated pinus palustris.

HONORARY DEGREE OF GLASGOW UNIVERSITY FOR SIR JOHN H. BILES.—At the graduation ceremony of Glasgow University, on the 22nd inst., Professor W. S. McKechnie, Dean of the Faculty of Law, presented, among others, Sir John Harvard Biles for the honorary degree of Doctor of Laws (LL.D.) in the following terms: Sir John Biles is emeritus Professor of Naval Architecture, Glasgow, a Knight Commander of the Indian Empire, and has, throughout an active life, been intimately connected with inventions and developments that have given to Great Britain a clear world supremacy in naval architecture. Educated at the Royal Naval College, Greenwich, where he was first student of his year, in naval architecture and engineering, he assisted in 1876 in the construction of the earliest ships of the Royal Navy to be built of steel (H.M.S. Iris and H.M.S. Mercury). Coming to Glasgow in 1880 as naval architect to the Clydebank shipyard, his subsequent career has been closely bound up with the best-directed activities of Glasgow business men in shipbuilding and engineering, an association leading not only to a series of personal triumphs for himself but contributing to the wealth and prosperity of the West of Scotland. In 1883 he designed the steamship America, which made a record for trans-Atlantic speed on a coal consumption of two-thirds of the fuel previously consumed. Two years later he constructed the first destroyer built in this country; and this is still in service at the present day. In 1887 there followed from his designs the City of New York and the City of Paris, the fastest Atlantic steamers of their day. Between 1886 and 1890 he gave notable assistance during the period when steel was superseding iron in the structure of the mercantile marine. These are merely a selection from the long list of his achievements before his appointment to the Glasgow chair. For many years Sir John Biles has been naval adviser to the Government of India, and he has also, on special invitation, placed his experience and skill at the service of the Governments of Canada, the United States, Japan, and Australia, visiting these countries and taking part in shipbuilding operations on their behalf. He designed and supervised the river craft for the Expeditionary Force in Mesopotamia in 1916–18, and received the formal thanks of the Secretary of State in Council for his help and success. Since his appointment to the Chair of Naval Architecture in this University in 1891, he has placed at the service of his students the lessons derived by him from his varied experiences, with the result that the Glasgow School of Naval Architecture is now the largest, best equipped and most famous in the world, attended, as the Mecca of the shipbuilding industry, by a polyglot crowd of eager students from most of the civilised nations of the globe. The Senate desires to mark its appreciation of Sir John Biles' distinguished services, not only to the University, but also during a long period of peace to the industrial development of the Clyde Valley, and to the Admiralty authorities, the British Navy, and the nation during the years of the world war.

"THE ELASTIC LIMIT."

To the Editor of Engineering.

SIR,—The passage quoted (page 792 *ante*) by your correspondent "Convinced" from the 1887 Proceedings of the North-East Coast Institution of Engineers and Shipbuilders, states at some length that if a test-piece be loaded past its elastic limit, relieved of load, and then be loaded again, the elastic limit is raised above its original value.

The bulk of experience shows this to be incorrect; for if the experiment described be carefully performed, the result is a slight lowering of the elastic limit. The quality of the material that is distinctly raised in value is the *yield-point*.

Only if a considerable time (24 hours is usual) after the relieving of the test-piece of load, be allowed to elapse before reloading is commenced, can the elastic limit be raised in this manner, and "Convinced's" excerpt makes no mention of such an interval.

The explanation of this mis-statement is not that the author had made any errors of observation, but that the confusion between the terms "yield-point" and "elastic limit," to which your correspondent Mr. Barclay, drew attention in your issue of June 9, is at least thirty-five years old.

I am, Sir, yours faithfully,
H. ROXBEE COX.

48, Station-road, King's Norton, Birmingham,
June 24, 1922.

"THE INTERNATIONAL EXCHANGE OF RAILWAY DATA."

To the Editor of Engineering.

SIR,—We have read, in ENGINEERING of May 26, 1922 (page 657), the article published on the Railway Congress held in Rome in April last. Our attention has been specially called to the paragraph "At all such congresses the language problem is a very real one . . .," in which you point out the difficulties met with by the English-speaking delegates to take an active part in the discussions.

We think we ought to remind you that Article 16 of the Statutes of our association stipulates that "The discussions shall be conducted in French or in the language of the country in which the congress is held. Speeches in any other language shall be translated into French." However, at the Berne session in 1910, at the request of delegates from English-speaking countries, a *résumé* of the discussions was given in English in each section in order that the said delegates might effectively follow the proceedings.

Special arrangements were made by the Organising Committee for the Congress at Rome for the translation into English of all documents, discussions in sections and proceedings of the general meetings. All the reports of the reporters were published in English and distributed to the delegates before the opening of the session.

For every subject or question a brief *résumé* of these reports was published in English so that delegates, whose appointment had been delayed (as was the case with several American administrations), were able to obtain sufficient information before the sectional meetings.

All the speeches and communications made in each section were immediately rendered briefly into English and published, *for the first time in a non English-speaking country*, in the English edition of the "Daily Journal." Sir Henry Fowler, chief mechanical engineer of the Midland Railway (England), was appointed a general secretary of the session, and although it was impossible for him to correct all the proofs of the "Daily Journal," he paid attention to the conclusions arrived at.

In addition, of the five sections of which the congress was composed, the presidency of two of them was confided to English-speaking officials: Mr. George Gibbs, chief engineer of electric traction, Long Island Railroad (U.S.A.), for the second section, and Mr. Gustav Behrens, a director of the Midland Railway (England), for the third section. The first section was presided over by a Belgian, the fourth by a Frenchman, and the fifth by an Italian.

It is possible that the organisation was not quite as satisfactory as we had hoped, but this was chiefly due to the small number of delegates from English-speaking administrations having sufficient knowledge of either of the official languages of the congress (French and Italian). We are already trying to discover what improvements can be made in this organisation for future sessions which do not take place in an English-speaking country.

We trust, however, you will be good enough to recognise that we have done the best we could to give every satisfaction to the English-speaking delegates.

We may also add that the English and American delegates generally expressed their appreciation of the arrangements made to assist them in understanding the discussions.

As the article which your estimable journal has published might be wrongly interpreted by readers having no knowledge of the organisation of the congresses of our association, we should be very glad if you would kindly publish this letter in an early number of the ENGINEERING under the same title as that of the previous article.

Yours faithfully,
V. TONDELIER, President.
J. VERDEYEN, General Secretary.

Commission permanente de l'Association internationale des chemins de fer, Rue de Louvain, 17, Bruxelles.
June 20, 1922.

[Our article was written in the light of personal experience of the proceedings of the International Railway Association at Rome, and with a copy of the Constitution of the Association before us. We expressly mentioned that an English edition of the "Daily Journal" was published, but the reports of the discussions, which it contained, were so extremely meagre and so inferior in quality to the corresponding French reports that many Englishmen were compelled to use the latter. In support of our contention we may mention that the discussion on "Locomotive Cab Signalling" is dismissed in six lines in the English edition, whereas the French edition deals with it to the extent of two and a-half columns. The main point of our article was that the French-speaking railways of the world are insignificant in mileage, capital expenditure or traffic in comparison with the railways in English-speaking countries, and that it cannot possibly be to the advantage of the majority of railwaymen that French should be the official language of the proceedings. As the railway administrations which constitute the association subscribe to its funds in proportion to their mileage, this is a further reason against the English-speaking delegates being placed in a position less favourable than that enjoyed by those of the French-speaking nations. Our view that there is a tendency to relegate the English-speaking railway-men, in spite of their much greater numbers and importance, to a subordinate position in the association, is confirmed by the resolution passed at Rome that in future no one but a Belgian should be eligible for the presidency or chief vice-presidency of the association.—ED. E.]

"DEVELOPMENTS IN THE USE OF PARAFFIN FOR COAST LIGHTING."

To the Editor of Engineering.

SIR,—I was greatly interested in perusing the article, under the above heading, published in the issue of ENGINEERING of May 5, and I think the writer of it is to be congratulated in giving such a clear and readable account of the advances made in constructing optical apparatus, and in the illumination of lighthouses by kerosene or paraffin oil.

He well says, in speaking of lighthouses of high power, that "the most economically efficient method" of illumination, is "undoubtedly by paraffin," and proceeds to describe in detail two incandescent oil burners, the Matthews and the Hood, with which the English lighthouses have been, and are now being, equipped. I presume the writer of the article is concerned only with the incandescent oil burners used in the English lighthouses, otherwise I cannot imagine his omitting to mention the "Chance" incandescent oil burner, which is used in other lighthouses than the English, and which, I venture to say from long experience, is one of the most simple and efficient incandescent burners on the market. Many years ago, when the question of substituting incandescent for oil burners in the lighthouses of the Madras Presidency was under consideration, I had occasion, after a long test with each, to decide whether to instal the "Matthews" or the "Chance" burner, and I had no hesitation in finally choosing the latter, for the main reason that while nothing could be said against the workmanship and efficiency of the Matthews burner, which was a beautiful piece of mechanism, I was afraid it was not simple enough in construction to place in the hands of the lightkeepers we have in South India, and that also it would be expensive to maintain. As the writer of the article seems to admit, the vaporiser was the difficult part of the Matthews burner, and its maintenance and repair proved to be an expensive item in the upkeep of the burner. In the Chance burner, the vaporiser is a most simple appliance, consisting as it does of two straight tubes joined together by a straight joint, and I have had no difficulty in repairing them out here time after time, until the tubes themselves have become worn out, and the vaporiser, in consequence, thrown away. The operation of heating the vaporiser in the "Chance" burner is as simple as the vaporiser itself, all that has to be done being to place a small methylated-spirit lamp under the vaporiser, and allow it to heat up the latter while the lightkeeper himself is attending to other duties elsewhere. Compare this with the Matthews burner, where the heat required to warm up the vaporiser is such as can only be obtained by the use of a blow-lamp, which the lightkeepers have to hold in their hands, and use with intelligence, during the whole operation. The blow-lamp is itself, practically, an incandescent oil burner in miniature without the mantle, and I could see that, placed in the hands of Indian lightkeepers, there was likely to be as much trouble with it as I anticipated would arise with the burner itself. To sum up, I have found, from long experience, that the "Chance" incandescent oil burner combines the three qualities of "simplicity of construction, economy in maintenance, and easy manipulation," considered by the writer of the article as being so essential in such appliances, and it may with safety be placed in the hands of unskilled men.

The Hood burner, now seemingly superseding the Matthews, has been constructed, it appears, not only to combine the above three qualities, but also to add to them the very great advantage of securing the maximum intrinsic brightness per area of mantle. This has been done by not only inventing a most ingenious and simple type of new burner, but using with it a new kind of mantle called the "autoform." The "autoform" mantle, I may say, has also lately been added to the "Chance" burner by making some slight alteration in the parts of the latter, so that it is still seemingly as up-to-date as ever. I have not yet tried the new kind of mantle with the "Chance" burner, but purpose doing so at an early opportunity.

In conclusion, I would like to add that I have no other motive in writing the foregoing than the desire to acknowledge the merits of a burner which has given me such satisfaction here since its installation, and which I consider does full credit to the reputation of the eminent firm of lighthouse engineers who placed it on the market many years ago. That firm I need hardly say are quite ignorant of the fact that I have written this letter.

I am, Sir, yours truly,
R. CUTHBERT, Captain,
Inspector of Lighthouses, Madras Presidency, South India.

Presidency Port Office, Madras, South India,
June 3, 1922.

ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on Wednesday, 21st inst., at 49, Cromwell-road, South Kensington, Dr. C. Chree, F.R.S., president, in the chair. Messrs. J. E. Clark, H. B. Adames and I. D. Margary presented the "*Report on the Phenological Observations for the Year* 1921." The report deals with a year of exceptional interest, and we find most notable responses on the part of both plants and animals to the exceptional conditions of almost unbroken drought and heat, the former in many parts unprecedented. After mid-December the mildness to late March was extreme, which gave premature fruit blossom and its usual concomitant of poor fruit crops, except apples. The four early spring flowers were over 18 days earlier than the thirty years' mean; April and May, 14 days, June 10 and July 6 days. Grain cutting was very early. The isophene flower chart, with its lines of equal flowering times, shows clearly this unusual earliness. The warm uprush along the Bristol Channel, and thence up the Severn and Dee valleys to include the Wirral Peninsula, is almost identical with the isophenal trend and values for 1920. In the north-east of Norfolk we find a recurrence of the cold area, so well marked in the years 1919 and 1920, spreading southward from the North Sea, and curving south-eastward by Norwich to include Bungay. The long tongue stretching from the Scottish border southward to include Leicestershire and Rutland, agrees well with that appearing on last year's map, as also does the interesting late area in the vicinity of Goole. The northerly bulge of warmth just north of the Isle of Wight is again very definite, as in previous years, and is confirmed by the thirty year average isophenes recently computed. As in previous reports, high ground is at once indicated by relatively late isophenal areas. Among exceptional effects may be noted the brief blooming period of the summer flowers and the earliness of autumn flowers, especially the michaelmas daisies; the dormant or destroyed seed-sowing experiences; the frequency of second blossom after the August rains, typically the horse-chestnut; the early departure of the swallows; the dearth of tortoiseshell and allied butterflies, apparently from lack of nettles. But in October Red Admirals abounded. October brought its own record in a week of unparalleled heat, whilst in striking contrast November opened with killing frosts. After a partial fall in late July trees had retained their foliage to an unusually late date and these frosts had the effect of many of the leaves turning brown and shrivelled as if from excess of heat. Planes and elms, with some others, were exceptions, and kept their green leaves almost, or quite, until December.

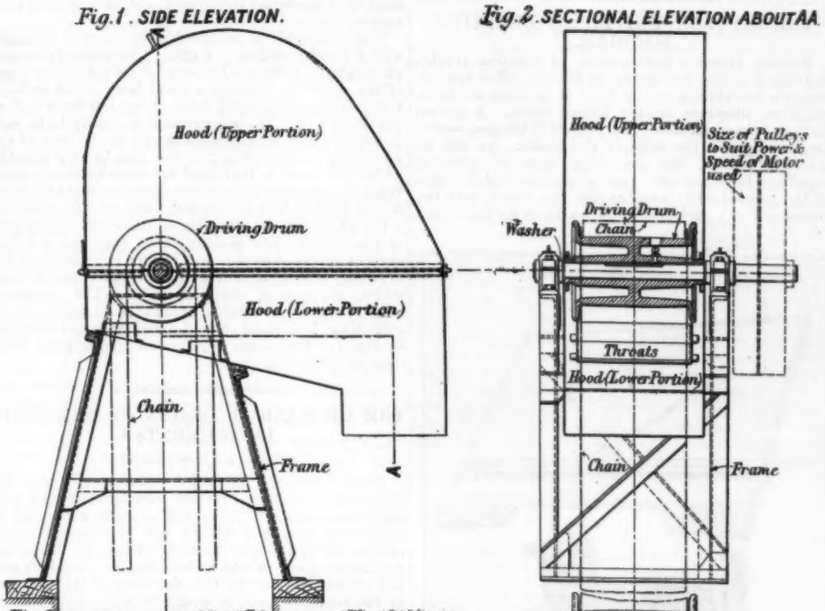
A second paper entitled "*An Observational Test of the Geostrophic Approximation in the Stratosphere*," by L. F. Richardson, A. Wagner and R. Dietzius, was read by Mr. Richardson. It is known from the work of Gold and of Dietsch that the wind velocity, at points not too near either the earth's surface or the equator, may be found with an accuracy of about 5 per cent. from the horizontal pressure gradient and the rotation of the earth, other considerations being ignored. A much more severe test of the error involved in neglecting other considerations, is obtained by inserting these "geostrophic" velocities in the equation for the accumulation of mass. If we proceed thus we obtain a theoretical equality, valid in the stratosphere, between certain derivatives of wind and of temperature. Some 70 observations connected with this question have been collected by Wagner and Dietzius; with the result that the quantities, which this theory makes equal, have in fact a positive correlation of about four-tenths.

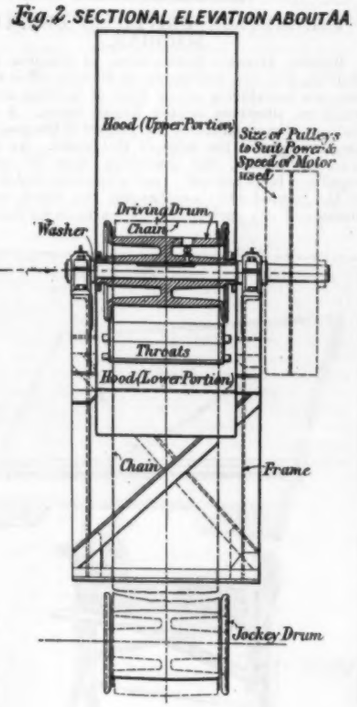
HEATING, VENTILATING AND DOMESTIC ENGINEERING.—The Education Committee of the Heating and Domestic Engineers' National Joint Industrial Council have issued a pamphlet containing advice to intending students as to courses of study in the above subjects. There are three centres of study in London and one each in 10 provincial cities. The pamphlet can be obtained at the price of 2*d.* from Mr. W. G. Hollinworth, secretary to the Education Committee of the Heating and Domestic Engineers' National Joint Industrial Council, 38, Victoria-street, S.W.1.

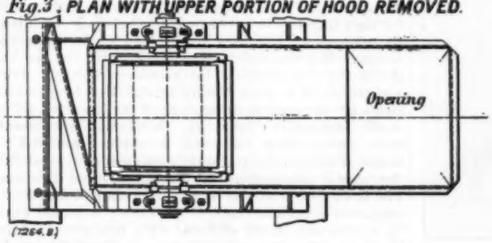
ROYAL AERONAUTICAL SOCIETY.—In accordance with the new regulations the first examination for associate fellowship of this society will be held on September 25 and 26 next in the library at 7, Albemarle-street, W.1; entries should reach the Secretary not later than August 28. It has been decided to utilise the society's R. 38 Memorial Research Fund in placing a memorial tablet in the society's offices, in awarding an annual prize of 25 guineas for the best technical paper on aeronautics, preference being given to those dealing with an airship subject, and in the selection and collation of information on the development of airship design up to the present stage. The interest from the Usborne Memorial Fund will be devoted to the award in every alternate year of a prize for an historical paper on any aspect of aeronautics. This prize, and that previously mentioned will be open to international competition.

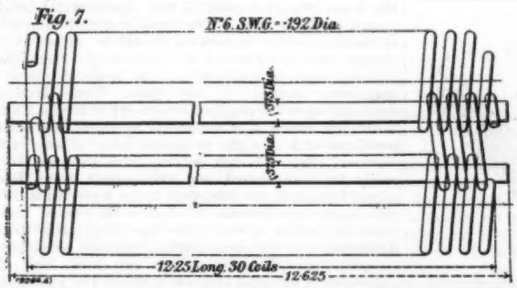
THE "AQUATOLE" ENDLESS-CHAIN PUMP.

CONSTRUCTED BY THE AQUATOLE COMPANY, LIMITED, ENGINEERS, WESTMINSTER.









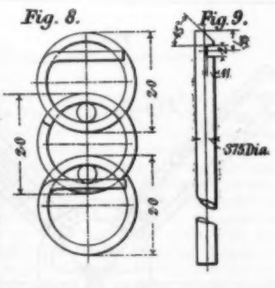


FIG. 4.

FIG. 5.

FIG. 6.

MOST of our readers are doubtless familiar with the method of raising water from a well to the ground level by means of an endless chain suspended from a driving pulley, and of sufficient length to allow the lower end of the loop formed to dip below the surface of the water. The chain is kept taut by a flanged roller hanging in the lower end of the loop, and to raise the water it is only necessary to run the chain at a fairly high speed. When this is done, the water entrained in the interstices of the chain is carried up with it and thrown off by centrifugal action as the chain passes round the driving pulley at the top. Many different forms of chain, several of which have been previously illustrated and described in our columns, are now on the market and have been employed fairly extensively—notably in connection with the water supply of H.M. Forces in France, Palestine and other centres of operations during the late war. For this particular application the simplicity, reliability and portability of the necessary plant are important advantages.

It will be obvious that the delivery, efficiency, durability and cost of the apparatus are largely affected by the design of the chain, and it is in these respects, as well as in some others which will be referred to later, that special advantages are claimed for the Aquatole liquid lifter, a particular installation of which we are about to describe. This installation, which we illustrate above, was supplied by the Aquatole Company, Limited, 34, Victoria-street, Westminster, S.W. 1, and was set up some months ago at the corner of James-street and Barrett-street, off Oxford-street, London, for raising water from one of the shafts of the Post Office tube railway, work on which has been suspended for the meantime. The sectional elevations and plan of the head gear given in Figs. 1, 2 and 3, serve to show the extreme simplicity of the equipment, which consists mainly of an angle-iron frame carrying two ball bearings, in which the shaft of the driving drum runs. The drum is of cast-iron, 8 in. in diameter and 13 in. wide between the flanges, and it is driven by belt from an 18 h.p. electric motor; a similar drum, shown in Fig. 2, hangs in the chain at the bottom of the shaft. A galvanised steel-plate hood, made in two parts hinged together, collects the water thrown off from the chain and delivers it through the opening in the lower part of the hood shown on the right of Figs. 1 and 3. Fig. 4 shows the water being delivered into a tank fitted with a vee notch for measuring purposes, while Figs. 5 and 6 illustrate the form the delivery takes when the upper part of the hood is raised.

The chain used in the Aquatole liquid lifter is the invention of Mr. J. Cameron Grant, and its design is illustrated in Figs. 7, 8 and 9. As will be seen, it is composed of a series of helical coils of steel wire arranged side by side with their axes at right angles to the length of the chain. The turns of adjacent coils, which are alternately right-handed and left-handed, penetrate one between the other, and are connected by a steel pin as will be clear from the illustrations. End movement of the coils is prevented by turning in

the wire at each end so that it fits into a slot cut in the pin, one of which is illustrated separately in Fig. 9. In the particular installation we are now dealing with, the chain has a nominal width of 12 in., but the exact dimensions of the coils and pins are shown in the illustrations. The coils, it will be seen, are 2 in. in diameter externally and are composed of 30 turns of 6 S.W.G. wire, while the pins are of ¾ in. steel rod. The form of construction is obviously simple, cheap, strong and durable, the two last-mentioned characteristics resulting from the distribution of the load and wear along practically the whole length of the pin. It is also a simple matter to disconnect the coils and to increase or diminish their number for the purpose of adjusting the length of the chain. The capacity of a chain of the dimensions illustrated is 20,000 gallons per hour with the driving pulley running at 350 r.p.m., at which speed the linear velocity of the chain, neglecting slip, would be about 920 ft. per minute. This size of chain is about the largest that can be handled conveniently, but the capacity of an installation can, of course, be increased to any reasonable extent by employing two or more separate belts in parallel. For smaller capacities, chains of somewhat similar design are made in widths ranging from 8 in. to 1½ in., the smallest being suitable for operation by hand power and being capable of delivering from 400 gallons to 800 gallons per hour.

To give an idea of the efficiency to be expected with this method of raising water we may quote the results obtained in a test of the installation above described, made by Sir Dugald Clerk on November 23 of last year. The report states that on this occasion the plant was run for a full hour and the water delivered, which was measured by a vee notch, amounted to about 300 gallons per minute. The chain ran at a linear speed of about 840 ft. per minute, and the water was lifted a height of 83 ft., while the immersion of the axis of the bottom roller was 15 in. below the surface of the water. Under these conditions the average horse-power represented by the water lifted amounted to 7·64. At a subsequent trial the water lifter was disconnected, and a brake fitted to the driven shaft to ascertain the power delivered to the pulley. The brake horse-power so determined, for the same output of the electric motor as on the previous trial, amounted to 13·98, so that the efficiency of the water lifter itself amounted to 55 per cent. The report adds that the chain ran with absolute smoothness and steadiness throughout, and also mentions that the water delivered was allowed to fall back down the shaft into the sump. Possibly as a result of this, a large amount of froth was delivered with the water, and the report points out that this may have prevented the highest efficiency from being reached. The makers inform us that in their own tests, in which the water delivered was not returned to the shaft, the amount of frothing was much less, and that an average efficiency of 60 per cent. has been obtained.

In these pumps the delivery and efficiency are not adversely affected by the height of lift, which is limited only by the tensile strength of the chain. The maximum lift possible in one stage with the type of chain illustrated is about 350 ft. If anything, the efficiency rises slightly as the lift is increased owing to the fact that as the chain leaves the surface of the water it drags up with it for a few feet a quantity of water in excess of that actually delivered. This water, which takes up a form somewhat resembling that of a stalagmite, falls back, so that the work done in lifting it is wasted, but the loss, of course, becomes a smaller proportion of the total work done as the height of delivery is increased. Another factor affecting efficiency is the depth to which the lower part of the chain is immersed. Since power is absorbed in moving the chain through the water, the highest efficiency will be obtained when the immersion is only just sufficient to allow the chain to fill properly, and this condition is fulfilled when the axis of the bottom drum is about 9 in. below the surface of the water. The delivery is quite unaffected by excessive immersion, but the efficiency is lowered, and it is therefore advisable, in cases where the water level varies considerably, to adjust the length of chain by adding or removing spare lengths as required. In special cases arrangements can be made for raising or lowering the chain by mechanical means incorporated in the design of the head gear.

A valuable feature of this method of raising water is the ease and rapidity with which the necessary plant can be installed. As an instance of this we may mention that, on one occasion, an installation of equal capacity to that described above was set to work within five hours from the time that the various components had been delivered on to the site. Three men were employed on the work, which included the building up of the chain from the separate coils and pins. Another useful feature is that the chain can be used with equal facility for lifting clean or dirty water, light or heavy oils, slimes, slurries, liquid manure, &c. Practically any liquid or semi-liquid substance can, in fact, be handled, though it may be necessary slightly to modify the design of the chain for exceptionally viscous liquids. The facts that the efficiency is unaffected by wear and that the plant can be operated by unskilled labour may also be mentioned in its favour.

THE SIMPLON UNIVERSAL DRAFTING MACHINE.

MESSRS. DARGUE BROS., LTD., of Simplon Works, Halifax, who are well-known as drawing office specialists, are introducing a new form of drafting machine, which we illustrate in the figures below. A special feature of the apparatus is that no part of the mechanism projects beyond the edge of the board. As will be generally known, the American type of machine requires a large amount of extra space around it owing to the jointed arms overhanging the board, and the absence of any such projecting parts, is an important

FIG. 1.

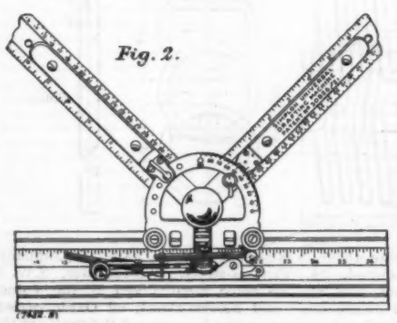


Fig. 2.

advantage of the new Simplon machine. Other valuable features are that horizontal lines of full board length may be drawn continuously, without any necessity for joining up, and that projecting may be made without reference to a base line. The number of bearings in the machine are stated to be 50 per cent. less than in the type already referred to, while an attachment is supplied by which the scales can be propelled along the rail in a self-acting manner for spacing lines of any desired pitch for sectioning or hatching. The board may be used in any position from horizontal to vertical.

The ends of the board are fitted with "L" shaped mahogany battens on which fine toothed gun-metal racks are fixed. The main straight-edge is of mahogany. It carries a steel spindle with end pinions engaging the racks, the spindle being enclosed in a wood casing. An inverted cast-steel channel-section rail, with a divided edge, is fixed to the straight-edge, and on this rail the protractor head travels on ball-bearing rollers. It is kept in alignment by a spring carrying two steel rollers which bear against the lower edge of the steel rail. The interchangeable scales are fixed to two metal arms carried by the drafting head. These arms are at right-angles one to the other, and are made in one piece, so that it is impossible for the scales to take up an incorrect position in reference to each other. This double arm member is anchored to the protractor head by a hardened steel pivot and swivels on a ball-bearing centre.

The protractor is engine-divided, and is operated with a Vernier reading to 6 min. For general purposes all standard angles are instantly obtained at the edges of the scales by pressing a small lever which releases a steel plunger engaging holes in the left-hand half of the protractor. The arrangement is clearly to be seen in Fig. 2. The arrangement shown at the base of the protractor head in Fig. 2 is the step-by-step gear by which the head is traversed for cross-hatching work. When the machine is in use the ebony knob at the centre of the head is held in the left-hand, and by means of it the whole moving part may be traversed to any part of the board. The makers claim that the machine shows a saving of 50 per cent. of time in all straight line drawing, as compared with the ordinary use of loose scales, set-squares, protractors, &c. The appliance may be used on a table or can be supplied on an adjustable iron stand of neat appearance as illustrated in Fig. 1. The board requires no counterpoise when used in different positions.

THE MECHANICAL DESIGN OF SCIENTIFIC INSTRUMENTS.*

(*Concluded from page* 794.)

Flexure Beams. Telescopes.—The errors due to the flexure of astronomical transit telescopes were exceedingly troublesome. Loewy had actually succeeded in measuring both the flexure and the partial errors introduced by the tube bending between the trunnions and object glass, as well as between the trunnions and the eye-piece. But he had not studied the variance of the telescope, and it would be very important to determine the hysteresis loop of transit instruments for the range of the telescope over the whole meridian; an analysis of the loop might lead to an improved design. We could not eliminate flexure, but we had the choice of materials of the necessary rigidity. With a material of a large Young modulus of longitudinal elasticity the stretch or squeeze of the fibres would be small. Generally speaking, however, instruments were mechanisms and not machines intended to transmit energy, and it was only necessary to investigate the elastic aberrations of the geometrical relations. The design of beams of analytical balances frequently suggested great ignorance of the theory of frame work. To secure maximum stiffness with minimum weight, the beam should consist of two equilateral triangles placed back to back. The cross-sectional dimension of the links of the framework should be settled by the permissible deviation of the knife-edges from their original relative positions in the vertical plane at maximum loading of the pans. That deviation depended upon the required sensitivity at the maximum load. By the aid of graphical methods the elastic problems of a straight prismatic piece of any cross-sectional shape (though defying pure analysis) could easily be investigated and the correct form determined for a definite deflection under a given load. It was more troublesome to deal with curved pieces when the radius of curvature was comparable to the dimensions of the cross-section, because exceedingly accurate draughtmanship was required, and the influences of external stresses to which the instrument might be submitted during operation could only be studied with the aid of models.

When the turning pair was used chiefly to maintain constancy between the parts transferring the forces or motion to the recording devices, a constancy of virtual length in the linkwork was a kinematical condition if the linkwork comprised only lower pairs, or a constancy of determinate virtual length for any given configuration if the linkwork comprised higher pairs. The case discussed by Professor Pollard was that of a single bearing having a loose journal, representing the allowance for a running fit. In Fig. 24, the two links, of the mechanisms of a measuring instrument, *e.g.*, of a hair hydrometer (indicated by the hair 3 on the left-hand side of the upper, smaller diagram), rotated about some centre. Assuming that force closure existed to keep the hair 3 taut and the bearing and journal in contact at some point, the journal in part slid and in part rolled around the interior of the bearing, and its centre described an arc of a small circle, the radius of which was equal to the difference in the radii of the bearing and journal. For ordinary motions, then, the point 1, 2 would move

* Abstract of three Cantor Lectures, delivered in February and March last before the Royal Society of Arts by Professor Alan F. C. Pollard, A.M.I.E.E., F.Inst.P., Department of Optical Engineering, Imperial College of Science and Technology, South Kensington.

in this arc, and the scale movement of the pointer tip would not bear a simple geometric relation to the change of length of the link 3. The case of a spindle rotating in ball bearings would be somewhat different, but the effect would be the same. When the maximum lateral displacement of the instantaneous centre of rotation was reached, some slipping would take place and the hysteresis loop would be flat in this portion of the operating range. The loop would then be made up of three phases, a lower lenticular portion, a middle oblong part, and an upper lenticular portion. This could be demonstrated by experiments. Clearance between the teeth of engaging gears and racks introduced backlash effects of the same nature as just outlined. In many cases the backlash of a gear element would be superposed upon that of the turning-pair elements.

In badly-made instruments, moreover, the hysteresis loop of successive runs would not concord as to shape or magnitude. This irregular variance might be expressed by reference to a family of probability curves, developed at various points along the instrumental scale. Another type of variance, that due to drift, had already been referred to with respect to aneroid altimeters. Drift was a time effect characterised by a gradual movement of the indicator asymptotically to a definite reading. The drift did not originate in the kinematic relations of the linkwork, but was due to an elastic after effect or to a viscous resistance. The after effect indicated overstrain such as certainly existed in the corrugated aneroid diaphragm.

From what had been said it was evident that variance and reproducibility of reading limited the useful sensitivity. Similarly the graduation of instruments was often far closer than the amount of variance justified. For testing instruments the mean interval of graduation should not be less than five times the mean variance; for commercial instruments the ratio of the unit of graduation to the variance might be 2:1. It was absurd to graduate a tachometer to 1 r.p.m., when the variance might be 5 r.p.m., and to read burettes to 0·01 cub. cm., when the amount of liquid clinging to the walls of the tube might amount to several tenths of a cubic centimetre.

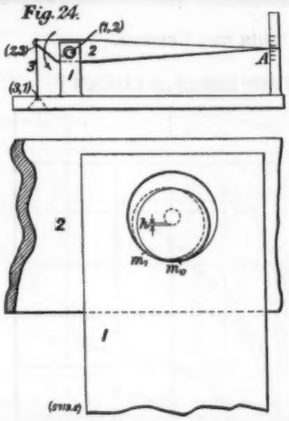
Nearly all instrument indications were measurements of a length; that applied also to arc measurements and to taking weights by means of shifting the balance rider. Sometimes the length to be measured had a measuring rod directly applied to it. In determining the height of the barometer, *e.g.*, the level of the mercury in the tank was brought to some fixed level by observing the reflection of a fixed point on the surface whilst the upper level of the column was ascertained by the coincidence of a fiducial edge with the meniscus. The late Lord Rayleigh pointed out that this method of applying the two ends of the measuring rod in different ways was liable to unnecessarily large errors; the probability that the errors of observation would cancel out was far greater when the sums or differences of readings were taken by the same physical procedure than when taken by different procedures. In his measurements of gas volumes Rayleigh used measuring rods of iron to determine the differences of the mercury levels by the same procedure.

The mercury manometers consisted of an upper and a lower glass bulb connected together at their lower portions by glass tubing. The lower and upper bulb were open at the top and the bottom respectively to admit the measuring rod, which was then sealed to the glass. The lower end of the rod in the lower bulb ended in a sharp point, the reflection of which could be seen in the surface of the mercury. The upper part of the rod ended in a stirrup with a central point directed downward, the reflection of which could likewise be seen in the surface of the mercury in the upper bulb. The two points were of the same shape and a determined distance apart. Thus the constancy of height between the two mercury surfaces in the two bulbs was indicated by the same physical procedure.

Functional and Manufacturing Design.—In its last stage, design divided itself into two main types, functional design and manufacturing design. In the early days the inventor brought his ideas to the mechanic; design was the outcrop of the mind of the mechanic who made a model and improved it; duplicate mechanisms were copies of this model. Interchangeability existed in those days only in a single instance, that of wheels and pinions for clocks and watches. The demand for these parts became so great that Hooke (1635–1703) suggested a machine for dividing and cutting the teeth in these parts, and the first machine supposed to have been made to Hooke's notion in France was described by Bion in his "Mathematical Instruments of 1702"—probably the first machine which manufactured interchangeable parts. Thiout's "Traité de l'Horlogérie Mécanique et Pratique," Paris, 1741, gave detail engravings of three gear-cutting engines, two provided with perforated dial plates and one with a worm for spacing. The manner in which those dial plates were divided was not clear, but Henry Hindley, a clock maker of York, described in a letter of 1748 to John Smeaton, how he divided the plate in his gear-cutting machine by a device which we should now call a "jig." Professor Pollard briefly explained these various devices (of Hooke, &c.) with the aid of slides.

In our days drawings were largely used specifying the functional design. But under present conditions with productive operations divided into elementary parts, and labour trained in specialised directions, when no one individual was capable of dealing with the mass of detail, the design had to cover a wider field and had to be more comprehensive and accurate. Manufacturing design was a later development of functional design, not in any way antagonistic to it. It gave in fact the information originally supplied by the mechanic in the early days, modifying the functional design to ensure economical and increased production, to reduce the assembly costs to a minimum, and to make parts requiring attention in service accessible. The latter could only be determined by actual service of the instrument, which was invariably subjected to abuses which the maker never dreamt of, but for which he was blamed. Manufacturing design was never complete; it would work itself out in practice, but that was a slow and expensive experiment, and continual alterations in equipment would spell loss of interchangeability. The experiment could better be carried out by the use of models. These considerations did not interest the manufacturer of small quantities; simplicity of design was, nevertheless, to him, as well as to the large producer, the key to economy of production.

Fig. 24.



In illustration of the importance of simplicity in design, Professor Pollard showed lantern slides of a number of manufactured parts which had subsequently to be redesigned for economical production, and indicated details of design important from the manufacturing point of view which we briefly summarise.

In castings it was necessary to avoid insufficient clearances on account of unavoidable irregularities, coring or small castings and large cores with small outlets. Insufficient metal on internal bosses was frequently the cause of costly waste, and all loose pieces on patterns should be avoided where possible. Small projecting parts and complicated shapes increased the cost of casting, and large masses rigidly connected to more slender parts set up undesirable cooling strains. It was far more economical in every way to design several pieces, each of simple shape, to be subsequently fitted together.

In designing parts to be machined, faces in enclosed positions or faces with insufficient landing space for the tool should be avoided. Blind holes and internal slotting were frequently responsible for bad workmanship. Lugs, bosses or extensions on faces to be machined were frequently met with and showed marked ignorance of economical workshop processes.

The instrument must be produced by established plant with the existing manufacturing equipment, or new plant must be created. In both cases all efforts must be made to reduce the machined surfaces of the components.

An excellent example of this was supplied to Professor Pollard by Messrs. Taylor, Taylor and Hobson, with regard to the War Office design and their own designs of a gun clinometer. The former was machined all over and was not designed for rapid mass production, costing about 4*l.* each with a maximum output of about 40 per week. In the re-designed instrument all unnecessary machining was avoided, and the unmachined parts were enamelled. All parts were made interchangeable at a cost of half that of the War Office design with a maximum output of 250 per week, using the same number of operatives, but employing accurately made tools and gauges to ensure rapid, interchangeable and accurate work.

Interchangeable manufacture itself involved the establishment of suitable limits on the functional surfaces and means of enforcing those limits. The limits were the laws of production, and the more liberal they were the more economic was manufacture.

Professor Pollard emphasised the importance of the drawing. There were two classes of drawings—functional and manufacturing or component drawings. The former, like functional design, specified the functional conditions to be maintained, and the details which did not appear were supplied by the mechanic who used these drawings. They were of the first stage in the evolution of a design. Manufacturing drawings, however, must supply all the information necessary for economic production. In addition to many other things, they gave the necessary component tolerances and allowances for interchangeability of parts, in such a way that there was only one interpretation.

Professor Pollard outlined Buckingham's five rules of dimensioning and showed, how a violation of these rules introduced ambiguity in the interpretation of tolerances and allowances with the result that parts would not be interchangeable, and also introduced the imposition of closer manufacturing limits than were actually necessary for the functional requirements of a component.

The importance of the drawings was frequently overlooked, and drawings violating the rules of dimensioning were greatly responsible for failure in interchangeable manufacture of composite surfaces liable to develop compound tolerances.

Means of enforcing specified limits was achieved chiefly by the aid of physical gauges; in many recent applications these had given place to optical gauges in which the principle of the interference of light was used or in which the shadow of the contour of the component was compared with that of a standard diagram or that of a standard component.

The course of lectures terminated with a demonstration of the beautiful Wilson comparator for optically checking the contour of any manufactured part, and especially for checking screw spindles. This instrument was loaned by the manufacturers, Messrs. Adam Hilger, Limited.

THE EFFECT OF TEMPERATURE ON SOME OF THE PROPERTIES OF METALS.*

By Professor F. C. LEA, O.B.E., D.Sc., of Birmingham, Member.

THE tendency to subject metals to increasingly rigorous conditions of temperature, as, for example, in high-pressure boilers and superheaters, high-pressure turbines using superheated steam, and particularly in internal-combustion engines, makes it necessary to investigate the fundamental properties of metals, not only at ordinary temperatures, but also at temperatures far above those at which testing is generally carried out in the laboratory. It is not sufficient to know the effect of temperature on the breaking strength of metals, for in many cases metals are subjected to repetition stresses at high temperatures, and thus it is important that the form of the stress-strain curves should be investigated, and in certain cases it may be of considerable importance to know the effect of temperature on the modulus of rigidity or the modulus of elasticity of the material. In other cases, as for example, in internal-combustion engine pistons, the tensile strength of the material at the temperature of working need not of necessity be very high, but it is important that the material, of whatever kind, should retain sufficient hardness to prevent deformation under stress. The effect of temperature, therefore, on the brittleness, hardness, limit of proportionality, yield-point (if certain metals have such a property as yield-point), modulus of elasticity, and finally, on the range of repetition stress to which materials may be subjected, becomes important.

The object of this paper is not to cover all the ground indicated, but to describe very briefly certain experiments that have been carried out during the last nine years, and to refer to results that may prove of interest in certain cases. The experiments have at times had special reference to particular engineering problems, while at others they have been undertaken simply as an attempt to add to our knowledge of the properties of metals, and in this connection some attention has been paid to "critical points" which may, or may not, be able to throw some light upon the rather extraordinary changes which take place in metals when subjected to particular temperature conditions. The "critical points" which occur in the curves show changes of particular properties with temperature, and are of great interest, as they apparently are related to important changes in the material, which take place at these particular temperatures. For example, the maximum strength in tension of mild steel bar at temperatures between 0 deg. C. and 500 deg. C., occurs at a temperature of 220 deg. C. approximately, and it is at this temperature that the minimum elongation per cent. occurs. Curves connecting the strength of heat-treated steel wires with

* Paper read at the Paris meeting of the Institution of Mechanical Engineers, June 15, 1922.

temperature show a critical point at about the same temperature, the point moving with the temperature as the carbon content is increased. Experiments also indicate critical points on the curve showing a change of torsional rigidity with temperature. Other workers out in an electrically-heated furnace of special design, and for temperatures below 15 deg. C. the tests were carried out in a special apparatus in which the cooling agent was carbon dioxide. The furnace consists essentially of a steel tube 4 in. outside diameter, and 2 ft. long, furnace have already been made, in which the whole apparatus described above is enclosed in an earthenware tube, with air spaces between the earthenware and the metal cylinder. By this means a temperature of 800 deg. C. or higher can be maintained for days with only a small expenditure of electrical energy. In all these furnaces the energy required to maintain a temperature depends entirely upon the insulation.

To measure temperature various types of thermocouples were used, but iron-constantin couples were generally found satisfactory. In some cases direct-reading instruments were used with the thermocouples, but usually a potentiometer was used for determining the temperature. The specimens, except in the case of wires, were in all cases screwed at both ends, and were usually made 0·564 in. diameter; the test length was 2 in. The extensometer for determining load-strain curves with precision, is shown attached to the specimen in Fig. 1, the furnace F being pushed back to allow the extensometer to be seen. Bars B and B_1 on each side grip the specimen by springs placed 2 in. apart. These rods are connected to horizontal tables sliding on steel balls, and the relative movement of the tables gives the extension of the specimen. The movement of the tables rotates special rockers. To the upper rocker is attached the mirror M_1, and to the lower the mirror M. A scale, placed about 8 ft. away from the mirrors, can be easily read through the telescope T. Elongations of $\frac{1}{10000}$ of an inch can be determined in this way with ease. By means of the extensometer, a number of types of which have been developed, load-strain curves of the specimens at any temperature up to 500 deg. C. can be obtained with considerable precision. Great care is required to see that the whole comes to a steady

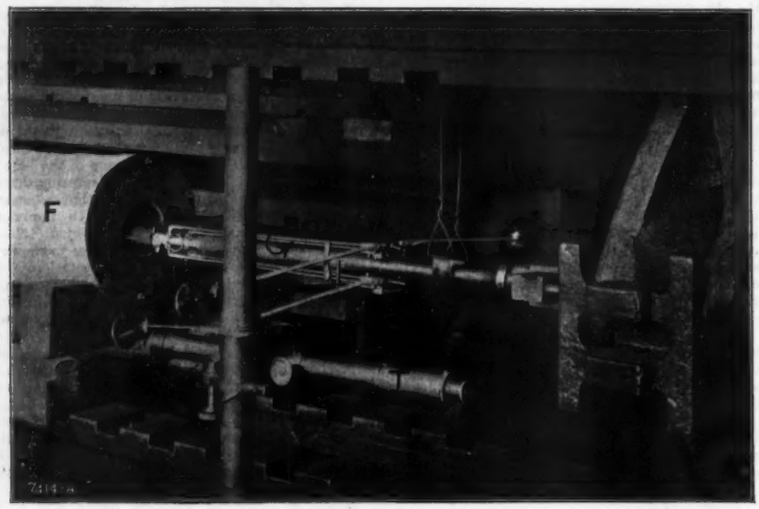


FIG. 1. EXTENSOMETER WITHDRAWN FROM THE FURNACE.

Fig. 2. TENSILE TEST ON "ARMCO" IRON. STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES.

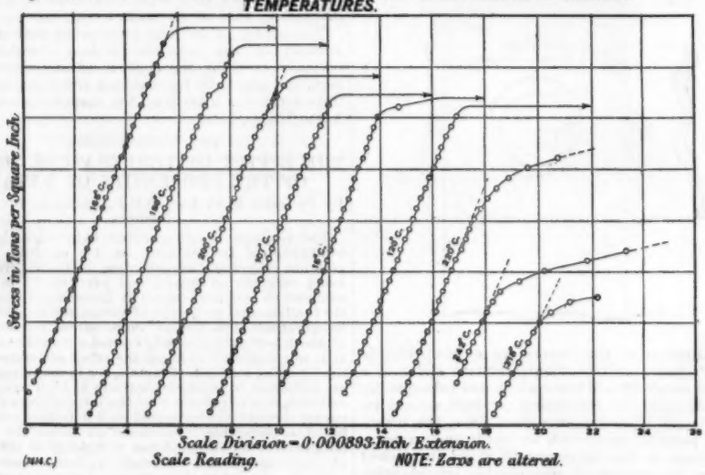


Fig. 3. TEMPERATURE-TENACITY & TEMPERATURE-DUCTILITY CURVES FOR "ARMCO" IRON. TEMPERATURE RANGE (-50 TO 450° C.).

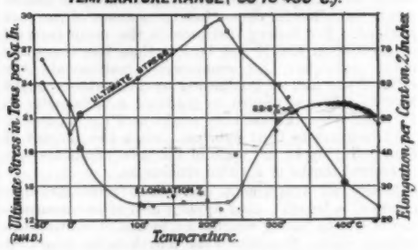
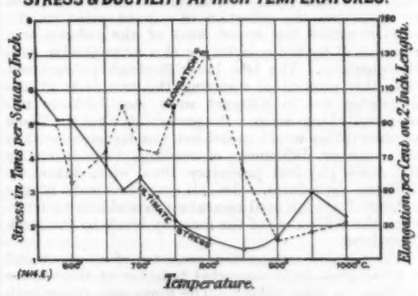
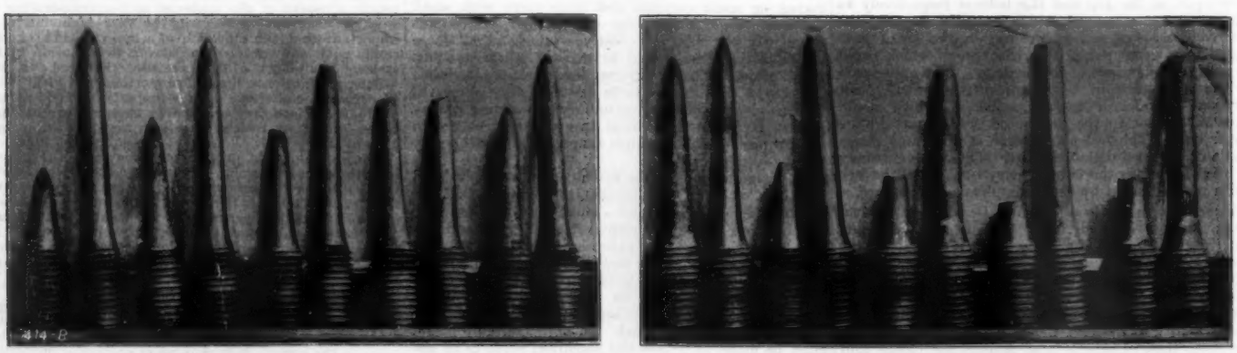


Fig. 4. "ARMCO" IRON. CURVES SHOWING ULTIMATE STRESS & DUCTILITY AT HIGH TEMPERATURES.





650 deg. C. 675 deg. C. 700 deg. C. 725 deg. C. 750 deg. C. 800 deg. C. 850 deg. C. 900 deg. C. 950 deg. C. 1,000 deg. C.

FIG. 5. FRACTURES OF "ARMCO" IRON AT VARIOUS TEMPERATURES.

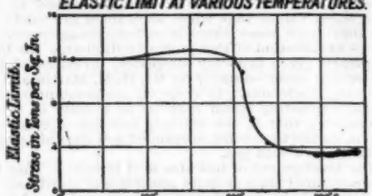
have shown that there is a "critical point" at about 214 deg. C. in the curve connecting the changes in magnetic permeability with temperature, and that this point moves with the composition and history of the material. Space and time, however, preclude more than a passing reference to these "critical points."

Tensile Tests at Temperatures from — 40 Deg. to 1,000 Deg. C.—Tensile tests at high temperatures were carried along which are laid strips of uralite, and round which ni-chrome wire is wound non-inductively. This is surrounded by asbestos fluff, and the whole enclosed in a metal cylinder about 10 in. diameter provided with steel end plates. Asbestos cloth is wrapped round the outer cylinder to allow of easy handling. The general arrangement of the furnace when in the horizontal testing machine is shown in Fig. 1. Modifications of this condition of temperature before readings are taken. The work is obviously laborious, as it takes a number of hours to make one test, and it is generally difficult to get through more than one test a day. The apparent limits of proportionality (elastic limit), modulus of elasticity, the creep points and the yield points, under any arbitrary conditions can be obtained.

Tests on "Armco" Iron.—This is a comparatively

pure wrought iron, containing less than 0·02 per cent. of carbon, 0·013 per cent phosphorous, 0·043 per cent. manganese, and 0·03 per cent. sulphur. Fig. 2 shows the stress-train curves obtained at temperatures ranging from 15 deg. to 318 deg. C. It will be seen that the elastic limit drops from 12 tons per square inch at 15 deg. C. to 3·6 tons per square inch at 318 deg. C., while the ultimate strength at 318 deg. C. is actually a little greater than the ultimate strength at 15 deg. C. Young's modulus changes from 12,900 tons to 9,400 tons per square inch at temperatures of 15 deg. and 318 deg. C.

Fig. 6. "ARMCO" IRON. ELASTIC LIMIT AT VARIOUS TEMPERATURES.



MODULUS OF ELASTICITY AT VARIOUS TEMPERATURES

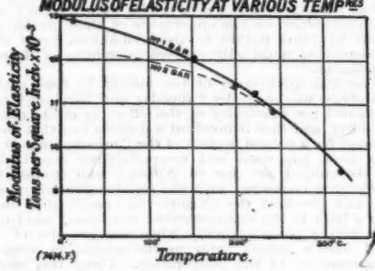


Fig. 7. STRESS STRAIN CURVES AT VARYING TEMPERATURES FOR STEEL WIRES.

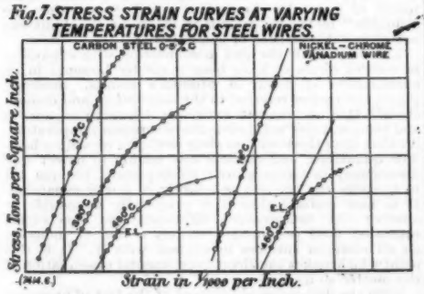
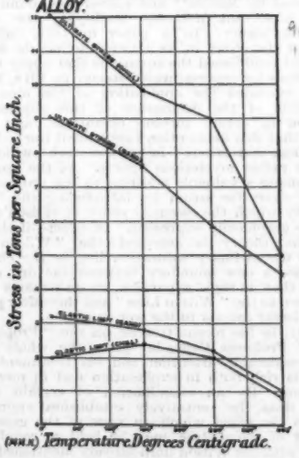


Fig. 8. TENSILE TESTS ON ALUMINIUM ALLOY.



respectively. Fig. 3 represents the ultimate strength and percentage elongation plotted against temperature, and the curves show a number of interesting points. For example, the breaking strength at − 40 deg. C. is greater than the ultimate strength at 15 deg. C., and the percentage elongation is also greater at the lower temperature. The maximum breaking strength occurs at about 220 deg. C. above which temperature there is a rapid diminution in strength until 600 deg. C. is reached, when some change apparently takes place in the material. Another change takes place at about 675 deg. C., and a further change in the neighbourhood of 800 deg. C. At about 900 deg. C. the material changes and between 900 deg. and 1,000 deg. C. it is clearly much more brittle than at 800 deg. C., which would indicate that for forging the material, a temperature of over 900 deg. C. is much more dangerous than one of 800 deg. C. These points are well brought out in the interesting series of photographs shown in Fig. 5. It will be noticed that the form of the fracture of the specimen confirms the existence of these "critical points" in a very remarkable manner. For example, at 650 deg. C. the specimen draws out to a fine point, and in Fig. 4 it will be seen that at 650 deg. C. the elongation curve is rising. At 725 deg. C. the elongation curve is passing through a minimum, and

TABLE I.—"*Armco*" *Iron.*

General Table of Results. (−38·5 *deg. C. to* 450 *deg. C.*)

Temperature in Deg. C.	Ultimate Stress.	Yield Stress.	Elongation.	Elastic Limit.	Young's Modulus.	Remarks.
	tons per sq. in.	tons per sq. in.	per cent.	tons per sq. in.	tons per sq. in.	
− 38·5	24·10	24·10	67·0	—	—	—
0	19·58	18·45	53·5	—	—	—
15	21·208	13·468	41·0	12·0	12,900	—
100	24·450	12·800	25·0	—	—	—
107	30·488*	13·200	24·0	12·4	11,900	New Material
120	30·768*	12·400	24·0	12·0	11,400	New Material
150	26·680	14·800	27·0	12·8	12,100	—
165	29·812*	15·200	25·0	14·0	11,600	New Material
200	28·946	13·600	25·5	12·00	11,400	—
220	29·480	12·336	23·0	6·40	11,200	—
242	25·780*	20·892	39·0	4·40	10,800	New Material
250	26·76	—	30·0	—	—	—
300	23·912	—	46·0	—	—	—
304	23·824	—	49·0	—	—	—
318	22·764	—	52·5	3·60	9,400	—
400	15·368	—	54·0	—	—	—
450	13·148	—	48·0	—	—	—

TABLE II.—"*Armco*" *Iron.*

General Table of Results. Range: 500 *deg. C. to* 1,000 *deg.*

Temperature in Deg. C.	Ultimate Strength.	Elongation.
	tons per sq. in.	per cent.
500	7·450	93·0
550	5·970	91·0
580	5·120	89·0
600	5·136	55·0
650	3·760	74·0
675	3·075	100·0
700	3·430	76·0
725	3·080	73·0
750	2·168	99·0
800	1·595	132·0
850	1·278	62·5
900	1·696	21·0
950	2·070	26·0
1,000	2·220	31·0

the specimen broken at that temperature shows a semi-brittle type of fracture, as will be seen on reference to Fig. 5. At 800 deg. C. the elongation curve again passes through a maximum, and the specimen pulls out almost to a point before fracture. At 950 deg. and 1,000 deg. C. the form of the fracture is almost like that of a brittle material. This is shown very markedly by the low elongation, Fig. 4. For the same material the changes in the modulus of elasticity and in the elastic limit due to temperature, are shown in Fig. 6. Heating and cooling curves for "Armco" iron show very marked critical points at 767 deg. C. and from 880 deg. to 900 deg. C. Tables I and II above show some of its properties at various temperatures. The material is somewhat variable as shown by points marked No. 2 in Fig. 6, which were obtained from bar No. 2.

Some of the data obtained from "Armco" iron, mild steel specimens, carbon steel, and alloy steel wires are summarised in Table III annexed. A comparison of the various parts of the table shows that steel wires containing upwards of 0·5 per cent. carbon have an apparent tensile strength of over 30 tons per square inch at 500 deg. C., but the limit of proportionality is very low and the time factor in loading is of great importance. Creeping takes place at comparatively low stresses, and the limit of proportionality is less than 7 tons per square inch. Nickel-chrome steel that has a breaking strength of 59 tons per square inch at ordinary temperatures, has at 460 deg. C. nearly the same breaking strength and limit of proportionality as a 0·5 per cent. carbon steel, quenched and tempered to have an ultimate strength of 102 tons per square inch at ordinary temperatures. Other interesting points can be observed in Table I. "Armco" iron and mild steel show a very distinct maximum breaking strength (see Fig. 3) at a temperature of about 220 deg. C., and the 0·5 per cent. carbon steels show a second maximum, at a temperature from 220 deg. C. to 300 deg. C. The point of maximum strength apparently moves with the temperature as the carbon content is increased, and the heat treatment is varied.

In Fig. 7 is shown the effect of temperature on the stress-strain curve of quenched and tempered steel containing 0·5 per cent. carbon, and on the stress-strain curve of nickle-chrome wires, containing 3·33 per cent. nickel, 0·61 per cent. Cr., and 0·1 per cent. Va.

A nickel steel, employed in the construction of turbines using superheated steam, when tested at 15 deg. C and 260 deg. C. gave results shown in the next column.

Temperature of Test.	Limit of Proportionality.	Ultimate Strength.
deg. Cent.	tons per sq. in.	tons per sq. in.
15	25·0	47·87
260	20·8	43·96

There is but little change in the modulus of elasticity, and the limit of proportionality is lowered by a greater percentage than is the ultimate strength. It is reassuring to find that at such temperatures the properties of these steels are so well retained.*

TABLE III.—*Showing properties of Iron and certain Steels at various Temperatures.*

Material.	Temperature of Test.	Ultimate Strength.	Elongation on 2 In.	Limit of Proportionality or Elastic Limit.	Modulus of Elasticity.
	deg. C.	tons per sq. in.	per cent.	tons per sq. in.	tons per sq. in.
"Armco" iron	15	21·0	41·0	12·0	12,900
	150	26·7	27·0	12·8	12,100
	220	29·5	23·0	6·4	11,200
	310	22·7	52·5	—	9,400
	500	7·5	93·0	—	—
Mild steel	15	32·0	26·0	—	13,300
	150	40·0	20·0	—	—
	220	43·0	18·0	—	12,750
	320	37·5	20·0	—	12,300
	500	17·5	32·0	—	8,500
	600	7·5	48·0	—	—
	700	4·0	70·0	—	—
	800	3·0	95·0	—	—
	900	3·0	82·0	—	—
	950	3·0	56·0	—	—
0·5 per cent. C. steel, quenched at 830 deg. C., tempered at 400 deg. C.	15	102·0	5·0	55·0	13,300
	100	98·5	5·0	51·0	11,900
	220–230	101·0	6·0	38·0	10,500
	260	100·0	14·0	35·0	10,500
	300–320	89·0	11·0	28·0	9,400
	460	43·0	11·0	7·5	—
0·5 per cent. C. steel, quenched at 830 deg. C., tempered at 550 deg. C.	15	66·0	9·5	48·0	13,030
	100	66·0	6·0	45·0	11,800
	220–230	71·0	5·0	37·0	10,400
	260	75·0	5·0	37·5	10,400
	300–320	73·0	12·0	36·0	10,200
	500	32·0	16·0	6·0	4,200
0·05 per cent. C. steel, quenched at 800 deg. C., tempered at 400 deg. C.	15	48·0	9·0	22·0	12,920
	100	49·0	8·5	23·0	11,940
	220–230	53·0	7·0	19·0	10,400
	260	54·0	7·0	—	10,000
	300–320	56·0	10·0	29·0	9,800
	380	63·0	9·0	15·0	8,800
	460	40·0	13·0	8·8	5,000
1 per cent. C. hardened at 800 deg. C.	15	98·0	—	77·0	—
	300	87·0	—	47·0	—
	400	69·0	—	36·0	—
	450	40·0	—	17·0	—
	500	32·0	—	less than 7 tons per in.	—
Nickel - chrome 3·33 per cent. Ni, 0·61 per cent. Cr., 0·10 per cent Va. Quenched and tempered	18	59·0	20·0	52·0	—
	200	54·0	16·0	36·0	—
	325	59·7	19·0	33·0	—
	450	42·0	20·0	15·0	—
Chrome-vanadium 0·91 per cent. chrome, 0·13 per cent. vanadium. Quenched and tempered	15	55·0	15·0	44·0	—
	200	52·0	13·0	30·0	—
	300	51·5	17·0	20·0	—
	400	49·0	18·0	23·0	—
Nickel - chrome wire, 60 per cent. nickel, 12 per cent. chrome, 24 per cent. iron	15	48·3	33·0	—	—
	150	46·7	29·0	—	—
	300	46·4	28·0	—	—
	400	44·5	27·0	—	—
	500	39·9	29·0	—	—
	600	31·4	35·0	—	—
	700	20·2	46·0	—	—
Nickel 95·5 per cent.	15	43·0	48·0	—	—
	150	46·0	46·0	—	—
	300	40·0	50·0	—	—
	400	32·0	51·0	—	—
	500	25·0	—	—	—
	600	17·0	62·0	—	—
	700	12·0	—	—	—

The Alloys of Aluminium and Copper.—Alloys of aluminium have been considerably used in the construction of pistons for internal combustion engines during the last seven years, and the author has published results of numerous tests elsewhere.† Subsequent experiments have shown that the results given in that paper are confirmed, and that under ordinary normal conditions aluminium alloy pistons work satisfactorily, but that there is always a danger of their burning out when the engine is overheated. There should not be the slightest danger of the aluminium piston failing, provided the temperature can be kept below 350 deg. C.; but any conditions that force the temperature above 400 deg. C. are almost sure to lead to failure. Certain aeroplane engines which came under the notice of the author, apparently gave no trouble in this respect

* Proceedings, Inst. C.E., 1919–20.

† "Aluminium alloys for aeroplane engines," Royal Aeronautical Society, 1919.

when working in the air; but many of the pistons which contained 12 per cent. of copper failed, on the test bed, when an overloaded condition for the last five minutes of the test were demanded. A result due, no doubt, to much higher temperatures being reached than were met with under normal flying conditions. Fig. 8 (for an alloy of Al 90, Cu 10) is typical of the aluminium alloys, and shows the results obtained for an alloy that was found suitable for the construction of aeroplane engine cylinders. This material is also suitable for pistons, although for this purpose it has no advantage over the 12 per cent. copper alloy.

*Hardness and Tensile Strength.**—The author has shown that the hardness curve for most metals is practically identical in form with that of ultimate strength throughout the temperature range. The hardness test gives a very ready method for determining the probable suitability of an alloy for internal combustion engine pistons or valve seats. Space prevents more than a passing reference to them here, but those interested will find particulars in the paper to which reference has been made. Table IV shows results obtained at 15 deg. C. and 300 deg. C. from certain types of bronzes, the composition of which are given.

Torsional Rigidity of Metals.—Four methods have been used by the author to determine the change in rigidity-temperature curve is very flat, and at 220 deg. C. there is a slight rise followed by a very rapid change. The critical points are being further investigated.

The modulus of rigidity of steel and other wires has been obtained at various temperatures by determining the time of oscillation of a wire of given length and dimension. For steel wires containing 0·57 per cent. carbon, normalised, annealed after drawing, and unnormalised, the curves of mean modulus of rigidity are shown in Fig. 11 where selected points are plotted. The curve is fairly straight for the first 280 deg. C. with distinct evidence of critical points, but after that begins to curve rapidly. The variation of the modulus of rigidity is approximately represented by the parabolic equation given in Fig. 11. This smoothed-out curve does not quite give the true story, but lack of space forbids the inclusion of curves showing more than this. As indicated above, there would appear to be a number of "critical points" in the curve, particularly in the neighbourhood of 230 deg. C. and 300 deg. C. These "critical points" are, however, being further investigated. It should also be remarked that the time of oscillation of steel wires does not appear to be altogether independent of the mode of approach to a particular temperature; after a certain temperature is passed, and the wire allowed to cool slightly, the time of oscillation may

TABLE IV.

Metal.	Composition.								15 Deg. C.				300 Deg. C.		
	Cu.	Zn.	Sn.	Pb.	Fe.	Al.	Mn.	Ni.	Ult. Stress.	Elongation.	Hards. No.	Elas. Limit.	Young's Modulus.	Ult. Stress.	Elongation.	Hards. No.
Bronze B.I.	60·25	37·90	0·28	1·37	0·20	—	—	—	28·59	15·0	121	6·4	6,660	15·12	15·0	86
Bronze No.20	58·15	38·94	1·05	0·63	0·25	—	0·98	—	35·70	24·0	143	10·4	6,560	17·70	62·0	105
Bronze No.18	59·50	36·72	0·63	0·90	0·56	1·06	0·63	—	37·48	25·0	137	7·4	6,800	10·42	78·0	114
Bronze (Nickel) H. Drawn	57·15	40·20	—	0·41	0·14	—	—	2·14	30·00	49·0	122	5·6	6,760	16·92	18·0	96
Bronze (Nickel) † Extruded	57·15	40·20	—	0·41	0·14	—	—	2·14	27·96	52·5	95	5·6	5,560	12·67	22·0	74

All stresses are in tons per square inch. Elongations given as percentages on 2 in. Hardness given in standard Brinell numbers.

Fig. 9. MILD STEEL. ELASTIC HYSTERESIS LOOP TAKEN AT 76°C. MAGNIFICATION: x10.

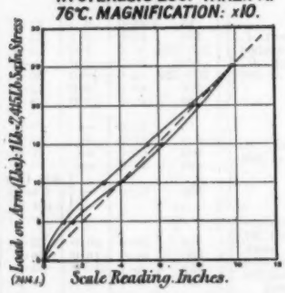


Fig. 10. VARIATION OF MODULUS OF RIGIDITY WITH TEMPERATURE OF MILD STEEL BAR.

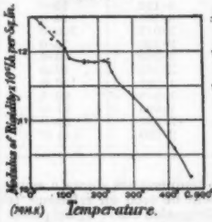
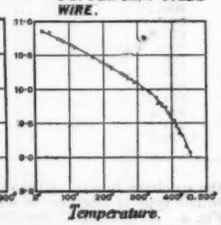


Fig. 11. RIGIDITY MODULUS VARIATION WITH TEMPERATURE FOR 0·57 PER CENT STEEL WIRE.



Note to Fig. 11.—There is distinct evidence of critical points at certain temperatures.

Diam.=0·103 in. $(N-8·56\times10^6)^2=(5·6-0·0115t)\times10^{12}$. N=mod. of rigidity. t=temperature deg. C.

the torsional rigidity of materials, but only a brief reference is made to them here:—

(1) By determining the time of torsional oscillations at various temperatures.

(2) By determining the time of oscillation of coiled springs at various temperatures.

(3) By determining the elongation of coiled springs at various temperatures.

(4) By measuring the torsional strain in bars heated in a furnace when subject to torsion in a sensitive machine.†

To obtain the torsional rigidity by the fourth method, a furnace 2 ft. long was used in order to obtain a uniform temperature on the 4-in. test-length near the centre of the furnace. The temperature was measured by an iron-constantin thermo-couple touching the specimen. Mirrors were attached to rods projecting from the furnace, the rods being connected to the specimen at points 4 in. apart. Two telescopes and scales set up at about 8 ft. from the mirrors were employed to measure the angular rotations of the mirrors. The relative rotations clearly give the torsional strain on the test-length of 4 in. Before loading the specimen, the temperature was kept constant for five minutes, and readings taken both on loading and unloading. The torque-strain curves obtained at various temperatures from a mild steel bar ⅜ in. in diameter are of interest. When plotted to the usual scale for such curves, these appear as straight lines; but by exaggerating the scale, in the manner previously described by the author,‡ interesting features present themselves. At a temperature of 76 deg. C., Fig. 9, a distinct hysteresis loop is obtained for a range in one direction of 2½ tons per square inch. At a temperature of 390 deg. C. a very large hysteresis loop is obtained for a range of stress of 2 tons per square inch, and at a temperature of 490 deg. C. creeping took place at a stress of 1·5 tons per square inch. The modulus of rigidity at various temperatures is shown in Fig. 10. Between 120 deg. C. and 200 deg. C. the modulus of change; in other words, the previous history has a slight effect upon the modulus of rigidity.

Conclusion.—The results of the tests described in this paper, together with other published and unpublished work, show clearly that below 250 deg. C. the effect of temperature, particularly on steels, does not give cause for anxiety in their use in cases where the above limit is not exceeded. They show, further, that many of the alloys of copper, also those of aluminium, are considerably affected by temperatures of 250 deg. C., and it is unwise to assume, because an alloy is as strong as steel or iron at ordinary temperatures, that it will remain so at higher temperatures. Temperatures above 350 deg. C., which may be reached in the case of aeroplane engine springs, may have a very marked effect on the elastic properties of steels. The limits of proportionality may become quite small, there are possibilities of hysteresis loops at comparatively small ranges of stress, and the moduli of rigidity and elasticity may be considerably less than at ordinary temperatures.

The author wishes to express his indebtedness to Mr. V. R. Collins, M.Sc., and Mr. E. A. Reeve, M.Sc., for their enthusiastic assistance in carrying out the experiments described in this paper.

* British Association. See ENGINEERING, vol. cx, p. 293.
† Proceedings R.S.A., vol. xciii, 1917.
‡ Proceedings R.S.A., vol. xciii, 1917.

THE SUPERSATURATED CONDITION AS SHOWN BY NOZZLE FLOW.*

By Professor A. L. MELLANBY, D.Sc., Member, and WILLIAM KERR, of the Royal Technical College, Glasgow.

General.—In many quite simple nozzle experiments investigators have obtained flow quantities in excess of those calculated on the assumption of isentropic expansion of saturated steam. This apparent anomaly has recurred so frequently that the fact may be held as well established. On all considerations, of course, the flow ought to be less than the theoretical, since any type of loss or imperfection in the expansion must reduce the discharge below the ideal value. Consequently, a result of this kind casts doubt on the soundness of the underlying theory. It may be remarked, however, that a certain number of the experiments commonly quoted to substantiate the result are hardly valid as exact evidence, since little attention was given to the initial wetness of the fluid. It is to be understood that the occurrence refers only to the flow of wet steam, or of steam which—according to the ordinary conception of vapours—would become wet during expansion; and it must be admitted that the flow quantities are, in such cases, so close to the theoretical values that when allowances are made for the inevitable losses there is definite disagreement.

The explanation of this excessive discharge has been frequently given and very completely investigated in a theoretical sense—notably by Mr. H. M. Martin and by Professor Callendar. It rests on the assumption that rapidly-expanding steam may be in a state of supersaturation; that is, the ordinary function of condensation is, for the time being, suspended and the fluid simply operates as a cold gas.

The development of this idea is of interest. That the supersaturated state is quite possible was clearly shown by Aitken* in his experiments on fog formation, when he demonstrated that condensation could not take place unless suitable and sufficient nuclei were present; and the explanation of the importance of these nuclei was given by Lord Kelvin in the well-known proof that condensation could only proceed on centres of definite dimensions.

The first application of the matter to heat engine operations was made by Callendar and Nicolson,† who explained the possibility of this effect in steam engine cylinders, and that it involved a definite loss that could account for a certain portion of the "missing quantity." The most important and comprehensive experiments on the subject are due to Wilson,‡ who studied the phenomena connected with the rapid expansion of wet air, and obtained the all-important result that there was a limit to the supersaturated condition, condensation taking place naturally when the pressure of the fluid bore a certain ratio to the saturation pressure corresponding to the temperature. Using this result, Callendar§ has shown that it implies active condensation nuclei of molecular dimensions; and, hence, that the "double" molecules present in steam at this limit can act as suitable centres of condensation.

The first use of the idea in connection with expansion in nozzles seems to have been made by Lorenz,‖ in an examination of some of Stodola's results. Stodola¶ shortly thereafter referred to the conception, and demonstrated that it involved excessive discharge in nozzles and temperatures well below the saturation temperature. At that time there was no clear evidence regarding large flow quantities, and Stodola was unable to detect any discrepancy in temperature; consequently, he was led to consider the occurrence unlikely in nozzle expansion. It is now realised that it is practically impossible to observe the temperature differences as the supersaturated fluid presumably creates a film of moisture on all material surfaces in contact with it. It is this point which makes the direct experimental examination of the matter so difficult.

With the definite establishment of the fact of excessive discharge in nozzles passing saturated steam the idea of supersaturation was independently and successfully resurrected by Martin** and placed in a sound position as an important influence modifying the ordinary expansion theory. In a paper in 1915, Callendar†† discussed the effect in its relation to nozzle flow very fully, and established the equations that apply to nozzle calculations for supersaturated steam. In 1918, Martin‡‡ greatly extended the application of the idea on the assumption of the persistence of this supersaturated condition in actual turbine operations, and demonstrated that this assumption rationalised the well-known "superheat corrections" in turbine work—which otherwise are rather mysterious figures. At the same time, Martin made a valuable addition to the ordinary heat-entropy chart for steam by introducing the "Wilson Line," by which the essential result of Wilson's experiments is graphically expressed. In effect—if the supersaturation theory is accepted—the "Wilson Line" replaces the ordinary saturation line in the chart and establishes a new boundary between the dry and wet fields so that, in rapid expansion, steam remains in a dry state down to the "Wilson Line" and thereafter partially or completely reverts to the wet condition.

Finally, in his recent treatise on the "Properties of Steam," Professor Callendar gives the whole matter very considerable attention and his treatment of the subject is rich both in explanation and in methods of calculation. By an examination of certain reaction turbine data, he tentatively establishes approximate limits to the effect which, in view of the general uncertainty of the matter, may be held as roughly conforming with the Wilson limit already mentioned.

On the whole, the evidence in favour of the theory is convincing as regards excessive discharge in nozzles, and

* Paper read at the Paris meeting of the Institution of Mechanical Engineers, June 15, 1922.

* Trans. Roy. Soc., Edinburgh, 1881.
† "On the Law of Condensation of Steam." Proc. I.C.E., November 30, 1897.
‡ Philosophical Transactions (A), 1897.
§ "Ency. Brit." 11th edition, article on "Vapours."
‖ *Zeits des Ver. deut. Ing.*, October 31, 1903.
¶ *Zeits der Ver. deut. Ing.*, December 5, 1903.
** ENGINEERING, January 10, 1913.
†† "On the Steady Flow of Steam through a Nozzle or Throttle." Proc. I.Mech.E., February, 1915.
‡‡ "A New Theory of the Steam Turbine," ENGINEERING, 1918.

circumstantial as regards turbine operations in general; but it has appeared to the authors that this important experimental evidence on flow quantities is extremely scanty and rests on a few isolated cases only. Although experiments of this kind are tedious, it would seem desirable to have the flow curves for steam in the region of the initially dry state clearly set up so that the nature and extent of this evidence may be well understood. At present the subject suffers from over development in a theoretical sense, and the almost complete lack of well-defined data renders even a narrow range of experimental results of value. The purpose of the present short paper is merely to give flow curves for a few simple convergent type nozzles in order to demonstrate this discharge effect with clearness; and to show the degree of support afforded the application of the theoretical conception to nozzles, by some actual experimental results.

Effect of Supersaturation on Flow.—Rapidly expanding steam is held to be in a thermally unstable condition on account of the high speed of flow, and its inability to condense within the time limits available. Condensation requires nuclei and a certain margin of time. In the absence or inadequacy of the former, or the insufficiency of the latter, the steam fails to act as a vapour and expands as a gas. Consequently, the relations governing the expansion of superheated steam will be applicable to this condition of supersaturated (or undercooled) steam. Under these circumstances the temperature will be well below the saturation temperature; the heat made available in the expansion is rather less than for normal expansion in thermal equilibrium; the volume of the undercooled steam is distinctly less; and it is easy to show that the flow so determined is in excess of that by the ordinary theory to the extent of about 5 per cent. When time is given after expansion, or when the limiting state for supersaturated steam is reached the fluid reverts to the normal wet condition with increase of entropy.

Such is the simple aspect of this matter in so far as it concerns the nozzle discharge; and it very aptly explains the case of excessive discharge, since the flow through a nozzle is controlled by the throat condition and expansion to this point is extremely rapid. Whether the condition can persist beyond the throat depends on several factors, but principally on the existence of a limit and whether that limit is completely operative at high speeds. The explanation would seem to apply very definitely to expansion to the throat, and hence the effect should be quite clearly seen in the flow curves. Since these large flows provide the most conclusive testimony, and are accepted as legitimate evidence of the existence of the supersaturated condition, any departure of the flow curves from what is required by the supersaturation theory will, with equal legitimacy, indicate a certain failure to achieve the full degree of undercooling. Moreover, any such modification will act on steam conditions that are within the "Wilson Line" since, in general, the expansion of initially dry steam to the critical pressure gives a state point that does not reach this limiting line. The importance of this matter lies in the fact that it is customary to assume expansion to the Wilson limit as involving complete supersaturation, and that reversion only takes place beyond that stage. The attitude of the leading authorities would seem to be that some amount of undercooling is always present in rapid expansion even well beyond the "Wilson line"; but in studying the matter from the view-point of discharge, it is not possible to envisage the nature of the effects in the extreme expansion ranges.

Form of the Flow Curve.—At the time of Professor Henderson's paper on Nozzles,* the authors were engaged on nozzle flow experiments at different initial superheats, and one of them contributed to the discussion on that paper by giving a flow curve for a convergent-parallel nozzle, which showed a certain peculiarity of form. This curve is reproduced as A B C in Fig. 1. It will be seen that, as the superheat falls, the flow reaches a maximum at a low degree, and thereafter remains practically constant down to the saturation temperature. The additional point marked X in Fig. 1 was also shown as indicating a discharge obtained with ordinary boiler steam, which had not been subjected to any special drying or heating process; and which was, therefore, certainly wet—but to an indeterminate degree. It may be stated here that a great many similar tests have been made on various nozzles, and in all cases the tendency towards a flat top in the curve as in A B C, Fig. 1, is distinctly noticeable, although the extent and degree of flattening varies widely.

In Professor Callendar's "Properties of Steam," the data shown in Fig. 1 have been used in illustration† of the supersaturation theory, but the result is presented in such a way as to indicate complete agreement with the theory. In drawing the flow curve through the observed points, Professor Callendar has employed X, Fig. 1, as the limit point for dry steam and so obtains the curve X B C, Fig. 1. This procedure is hardly legitimate since thereby a point which certainly represents the flow with initially wet steam is taken as competent to represent the dry condition. Actually the point X should have been plotted somewhere on the left of the axis through zero superheat, and, consequently, should not influence the form of the curve in the superheat range. By so drawing the curve the important point of the change in form is completely obscured, and the real significance of the experimental results lost.

The flow through a nozzle in pounds per second per square inch can be expressed as follows for the case of superheated or supersaturated steam expanding without loss:—

$$\left(\frac{G}{A}\right)_t = \left(\frac{P_1}{V_1}\right)^{\frac{1}{2}} \left(\frac{r}{0{\cdot}718}\right)^{\frac{1}{n}} \frac{(1-r^a)^{\frac{1}{2}}}{r^a} \quad . \quad . \quad (1)$$

where $\left(\frac{G}{A}\right)_t$ indicates pounds per second per square inch theoretically; P_1 and V_1 are initial pressure and volume respectively; r is the ratio of expansion $\left(\frac{P}{P_1}\right)$ at the position where A is measured; a is $\frac{n-1}{n}$ with $n = 1{\cdot}3$ for dry steam. For the maximum value of $\left(\frac{G}{A}\right)_t$ it is only necessary to make $r = 0{\cdot}5457$, the critical pressure ratio.

Using equation (1) with $P_1 = 76$ lb. per square inch (absolute), and $r = 0{\cdot}5457$, the curve L M N in Fig. 2 is obtained which shows the variation of flow with initial temperature, and indicates a continuous drop in flow with increasing superheat.

Equation (1) also gives, with sufficient accuracy, the flow curve for the case of supersaturated expansion from initially wet conditions; it is only necessary to use the appropriate value of V_1. In this way L K, Fig. 2, is obtained and shows continuous increase of flow with increasing wetness.

The complete curve K L M N, Fig. 2, thus gives the

Fig. 1. FLOW CURVE FOR A CONVERGENT PARALLEL NOZZLE.

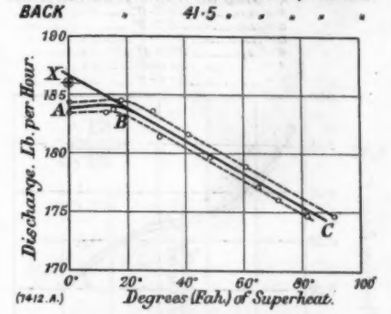
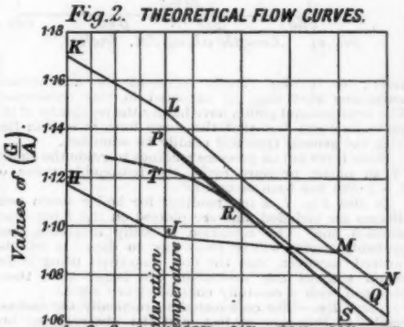


Fig. 2. THEORETICAL FLOW CURVES.



variation of flow for initial states wet and superheated under the theoretical conditions of no energy loss and complete supersaturation.

In order to establish the corresponding curves for the case of stable expansion of wet steam, it is necessary to work direct from the steam tables; and the tabulated Gibb's function values in the Callendar tables are especially helpful in this respect. Thus the curve J H, Fig. 2, is derived, and it will be seen that the flow values recorded by it are distinctly less than in the case of supersaturation. In fixing up J H a pressure ratio of 0·580 has been used, as this is the more correct value for wet steam. The point M, where the two curves meet, is readily determined by means of the adiabatic relation:—

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^a = \frac{1}{r^a}$$

with $r = 0{\cdot}5457$; T_2 the absolute saturation temperature at P_2; and T_1 the absolute initial temperature.

The straight line joining J and M then gives the flow curve for expansion in thermal equilibrium from initially superheated conditions. The exact form of J M will really depend on the variation of the critical pressure ratio, and the assumption of a straight line is equivalent to assuming this variation; but greater accuracy is not required.

The curve H J M N, Fig. 2, represents the changes in flow as the initial condition becomes dry, then superheated on the assumption that the expansion is stable throughout. It is to be noticed that, besides the effect of a reduction of about 5 per cent. in the flow, these theoretical curves are distinctly different in form.

In any actual expansion, however, energy losses occur and the curve P Q, Fig. 2, indicates a case in which a loss of 2·3 per cent. is allowed, and the steam assumed to be completely supersaturated throughout. The calculation is by means of a modified form of equation 1, namely*:—

$$\left(\frac{G}{A}\right)_k = \left(\frac{P_1}{V_1}\right)^{\frac{1}{2}} \left(\frac{r}{0{\cdot}718}\right)^{\frac{1}{n}} \frac{(1-k-r^a)^{\frac{1}{2}}}{(k+r^a)} \quad . \quad (2)$$

in which $\left(\frac{G}{A}\right)_k$ represents the flow for a loss defined by the factor k. For the curve P Q, k has been taken as 0·003 and r as 0·5457; and the constancy of these figures means that P Q is a curve of constant efficiency. It will be seen that an energy loss in expansion has the effect of reducing the excess flow due to supersaturation, and consequently in cases of large losses it may not be possible to observe excessive discharge. Such elimination of the excess quantity takes place in long convergent parallel nozzles.

Again, nozzle experiments give a certain indication of a decrease of efficiency with increase of superheat. It is unnecessary here to enter into a discussion of this variation; but the effect would be to make the supersaturated flow curve with loss resemble such a line as P R S, Fig. 2, which has been arbitrarily determined with a starting point at P.

The general result then is that, for completely supersaturated expansion accompanied by energy loss, the flow curve should be of the type indicated by P R S, Fig. 2. As the superheat falls, this curve rises with slightly increasing slope; and hence even when the actual flow curve is not widely different in value from such a case as P R S, if its curvature is of the opposite tendency at the low superheats, it would indicate a departure from the condition of completely supersaturated flow. The actual curve given in Fig. 1, annexed, is of this type, and the general form for this assumed case is as shown by the imaginary curve T R S in Fig. 2. This curve is continued into the field of initial wetness merely to indicate that the discharge for wet steam may be expected to be rather greater than for the initially dry condition; and hence the point X in Fig. 1 should not be considered as having any influence on the form of the flow curve in the superheat section.

On first thought it might be supposed that other reasons could satisfactorily explain the small depression of the curve T R S below P R S in Fig. 2. But consideration of the various effects that might cause this will show that they are contained in the main argument of incomplete supersaturation. Thus it is possible to conceive: (1) That the law of energy loss may change in this region, and (2) that the pressure ratios of action may alter; but both of these entail the belief in some change in the characteristics of the fluid; that is, in some degree of reversion from the dry to the wet state. Hence the primary cause of any such form as is here emphasised lies in the failure to attain the fully supersaturated condition.

If the completely supersaturated state is not to be expected, it should be realised that the divergence from that condition may vary widely in different cases, since the undercooled state is one of dynamic stability only, and is probably liable to extreme changes on the slightest cause.

Experimental Results.—The results which it is proposed to consider here comprise recent tests on:—

Nozzle A_1: 0·2507 in. diameter; ¼ in. length; $\frac{7}{32}$ in. radius of entry.
Nozzle B_1: 0·2513. in. diameter; ¼ in. length; $\frac{7}{32}$ in. radius of entry.

and tests of some years ago on:—

Nozzle A_2: 0·251 in. diameter; ¼ in. length; ⅛ in. radius of entry.
Nozzle B_2: 0·250 in. diameter; ¼ in. length; ¼ in. radius of entry.

All four nozzles are of the simple convergent or convergent parallel type; but A_1 and B_1 were used in conjunction with a search tube, so that the tests thereon include pressure measurements as well as flow determinations. Only flow tests were carried out on A_2 and B_2, as these were not fitted with a search tube.

In all cases flow determinations were made with varying initial superheats at a supply pressure of about 75 lb. per square inch (absolute). The tests were started at the high temperature values, and worked downwards to the dry condition. The authors' apparatus (which has been described elsewhere) is not well suited to this work, as the control on the gas superheaters employed is hardly fine enough. The establishment of any given temperature was therefore a very tedious process, as it was necessary to ensure a very steady thermometer reading before starting a test. In most of the recorded tests the variation of temperature during the period of measurement (from 15 minutes to 30 minutes) did not exceed 1 deg. F.; and in a very few cases only did the average differ from the extremes by as much as 1½ deg. F.

The initial pressure was kept steady throughout any test, but naturally the variations in atmospheric pressure over long periods prevent the attainment of a common supply pressure in all the tests on any one nozzle. To cover this effect the actual flow quantities are reduced to a standard initial pressure by direct ratio—since the variations are relatively small. For nozzles A_1 and B_1, this standard pressure is 76 lb. per square inch (absolute), and for A_2 and B_2 74 lb. per inch (absolute).

In all the tests dealt with here, the back pressure in the exhaust space beyond the nozzle was below the critical value, so that the measured discharge is the maximum for the fixed pressure and temperature. Also,

* "Theory and Experiment in the Flow of Steam through Nozzles," Proc. I.Mech.E., February, 1913.
† "Properties of Steam," page 245.

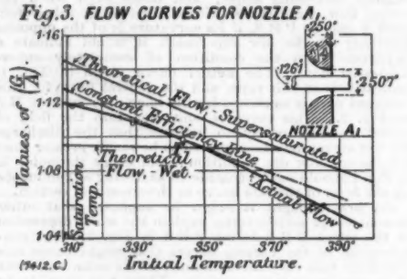
* "Steam Action in Simple Nozzle Forms," Brit. Assoc., Section G., August, 1920. ENGINEERING, September 3, 1920.

this low back pressure allows the jet to establish its own pressure range and therefore the search tube observations provide an opportunity to detect any change in the nature of the expansion in the region under discussion.

Since only the form of the flow curve really affects the findings of this investigation, the absolute measurement of nozzle area may be slightly in fault without affecting the results. This point is emphasised as the nozzle sizes in the older tests are not known with the accuracy of the more recent experiments. In all cases the basis area is corrected for temperature.

The results from the different nozzles may be presented separately :—

Nozzle A_1.—The flow curve obtained in this case and reduced to the standard pressure of 76 lb. per square inch (absolute) is shown in Fig. 3; and all the actual observations lie on a well defined curve. The pressure ratio values at the outlet, as determined from the search tube readings, are shown in Fig. 4, annexed. It will be noticed that there is no great difference in the pressure values throughout the whole range of the tests. If it is possible to distinguish a change, it is of the order indicated by the double curve given in Fig. 4; in which the top curve is drawn through the readings obtained at zero superheat, and the lower curves through those at a superheat of about 40 deg. The general tendency—if considered definite—is a rise of the pressure ratio with fall of superheat through the debatable range. This tendency is of the correct order, as any reversion will serve to maintain higher pressures. The differences are, however,



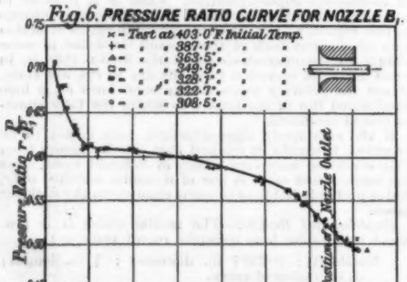


Fig.6. PRESSURE RATIO CURVE FOR NOZZLE B1.
x - Test at 403·0° F. Initial Temp.
Pressure Ratio r = P/P1.
Position of Nozzle Outlet
(7412.F)
Length along Jet. Inches.

very small, and the main duty of the curve of pressure in this case is to define the ratio at the outlet section, so that the correct theoretical flows may be compared with the actual. This ratio may be taken as 0·570.

Using this value, the theoretical flow curve for the supersaturated condition is obtained as shown in Fig. 3. A corresponding theoretical curve for stable expansion is also given, and it will be seen that the excessive discharge condition is quite clearly in evidence.

By means of the theoretical supersaturated curve, it is easy to obtain a constant efficiency line which is tangent to the actual flow curve. Such a line is shown in Fig. 3, the point of tangency being at T, at an initial temperature of about 345 deg. F. Both above and below this temperature the actual curve departs from the constant loss curve, and if the difference on the high temperature side is due to change in the loss value, that on the low temperature side cannot be so explained since the same type of variation would raise it above the constant loss line. Moreover, on the higher side of the 345 deg. F. position, there is no doubt as to the nature of the expansion since, allowing for losses, the expansion curve must be almost wholly in the superheat field, whereas, on the low side a rapidly increasing portion is in the wet or supersaturated field.

It is, therefore, reasonable to suppose that the discrepancy between the constant loss line and the actual flow curve indicates an incomplete condition of supersaturation; and it must be pointed out that the assumption of this discrepancy as a measure of the incompleteness rather underestimates the effect, since the basis curve should rise more rapidly from the point of tangency in order to represent a decreasing loss.

For simplicity, however, in view of the fact that the variation of total expansion loss is different with different nozzles, the general procedure may be followed in all cases of comparing the actual flow curve with the curve of constant efficiency which is tangential to it; and this comparison may be limited to the range of temperature below the point of tangency.

Nozzle B_1.—The same processes applied to the data for this nozzle give Figs. 5 and 6. It will be seen that the higher loss in this nozzle tends to obscure the effect of large flow quantities, since the top points on the flow curve are practically in line with the maximum flow on the normal assumption. The curve itself is very close throughout to the constant efficiency line, showing that there is less departure from the supersaturated condition and from the condition of constant loss. This latter result is natural as in a convergent parallel nozzle, the major portion of the loss is independent of initial conditions; whereas, in a short convergent type, the main loss is influenced thereby.

The pressure ratio values are marked in Fig. 6 and, as will be seen, it is quite impossible to separate any individual curve from the others, although a careful observation will show that in the straight horizontal part of the expansion curve, the lower superheat values have the higher positions—as was obtained with the previous nozzle. The outlet pressure ratio is in this case 0·513, and although this is rather lower than is actually possible, if the last fraction of the nozzle length is really effective, it has been used for the purpose of drawing the necessary theoretical curve in Fig. 5, since small differences in this matter have little effect on the results.

Nozzle A_2.—In this case no search tube is in use, so that the flows through the full bore nozzle are measured. The curve is shown in Fig. 7. The "excessive discharge" is noticeable, but the most obvious difference with the previous results lies in the much more definite flattening of the top of the curve. This may be due to the absence of the central search tube in the bore; to some small differences in the apparatus or conditions of the earlier

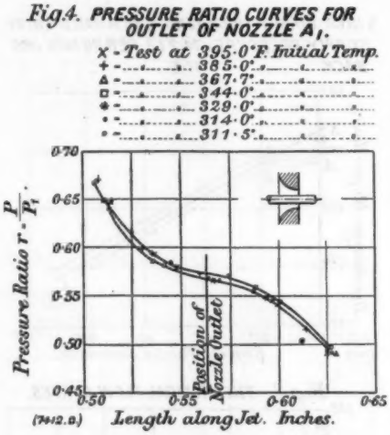


Fig.4. PRESSURE RATIO CURVES FOR OUTLET OF NOZZLE A1.
x - Test at 395·0° F. Initial Temp.
+ - 385·0°
Δ - 367·7°
□ - 344·0°
✱ - 329·0°
• - 314·0°
○ - 311·5°
Pressure Ratio r = P/P1.
Position of Nozzle Outlet
(7412.D)
Length along Jet. Inches.

tests; or it may simply represent the adventitious variations that may be expected in this occurrence. The experimental points have hardly the regularity of the previous cases, but that the curve form is well in line with the general type will readily be admitted.

Since there are no pressure readings to guide the choice of an outlet pressure ratio, the reasonable value of $r = 0·560$ has been assumed.

In this Fig. 7, a few readings for boiler steam conditions are included, and are plotted on the 2 per cent. wetness line, The condition is really indefinite, and probably varies widely from day to day. It will be noticed, however, that the flow quantities using boiler steam without any preheating are larger than those obtained with a carefully controlled dry state.

Nozzle B_2.—This case includes practically the earliest results of this class of test, and the observations are plotted in Fig. 8. The experiments extend over a period of three months and it is probable that, at that time, the experimental error involved in flow and temperature measurements had not been reduced to the small margin that may now be claimed. The existing records are, however, silent regarding any questionable experiments in the series, and all have been used in the plot. Where several experiments have been made around the same temperature value, the mean of the different results has been marked in the diagram. Thus the point numbered 1 in Fig. 8 represents the mean of nine tests, and the points numbered respectively 2, 3, 4, 5, 6 and 7, give each the mean of three tests. The other points represent single tests. In all about 40 tests are included, and it will probably be allowed that the mean curve sketched is the best representation of the whole series. This case adds nothing that is new to the general result and is given mainly to show that, even where extreme care is not taken in the experimental work, the general flow curve type still appears. The overall pressure ratio chosen in this case is 0·530, and gives the theoretical curves indicated. The flow curves that have been presented for these four nozzles show certain variations between themselves, but they all agree on the two points :—

(1) That the flow, at and near the initially dry state, is excessive when compared with the theoretical, as obtained on the assumption of stable expansion.

(2) That the form of the flow curve over a small range of superheat beyond the initially dry condition, is not in agreement with the theoretical assumption of complete supersaturation on any rational basis of expansion losses.

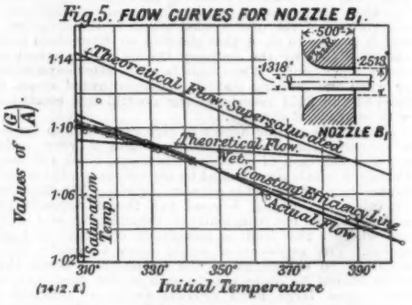
The former elucidates the nature and magnitude of the much discussed "excessive discharge"; and demonstrates that the ordinary assumption of "wet" expansion is not a suitable theoretical basis. It is also seen that the flow may still be anomalous on this basis, although it may not be in excess, since the expansion losses control the actual margins.

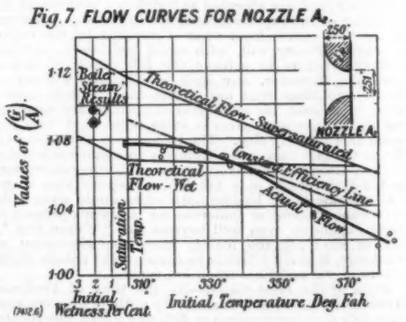
The latter point indicates very conclusively that there is a departure from the condition of complete supersaturation during expansion; the difference is not perhaps great, but it is always shown. Now it must be realised that this discrepancy occurs in the rapid expansion to the throat of the nozzle, and at steam conditions that lie within the Wilson limit; and both of these are supposed to tell strongly against the possibility of any reversion to the normal state.

In the choice of nozzles to illustrate these flow effects, the longer parallel types have been discarded since the extreme frictional occurrences and the shorter range of the rapid part of the expansion obscure the main result. The pressure curves for such types, however, tend to give a clearer differentiation of the individual cases, as the higher pressure values at the lower superheats are more definitely indicated in the slow expansion regions.

Consideration of Result.—Having established the flow curves and emphasised the special point, an effort may now be made to show the effect quantitatively, and in more direct terms. The theory of the subject is well developed, but does not lend itself readily to the special calculation involved herein, so that the following brief development is given in order to describe the method of calculation used; it does not profess to be an examination in strict theory.

The tangential constant efficiency line drawn against





all the flow curves is taken as representing the flow on the assumption of complete supersaturation, but including the effect of the expansion losses—which are known through this efficiency. Within the range which concerns the present matter the actual flow is less than this in the ratio :—

$$(1 - y) : 1$$

y being a small quantity.

Now if the reading of the flow curve form, as indicating a partial reversion from the fully supersaturated condition, is sound, then this reduction of flow means a corresponding increase of specific volume due to reversion. Flow per square inch of area depends both on heat drop and on specific volume; but the heat drop is not affected by reversion since that simply entails increase of entropy at constant heat. Hence if V_2 is the volume after expansion to P_2 for the case of no reversion, and $V1_2$ the value of the case with reversion, then :—

$$V1_2 = V_2 (1 + y),$$

also the heat H_2 at P_2 is, as explained, the same for the basis case and for the actual case.

If the actual reversion is supposed represented by a condensation of x lb. in every pound of the fluid, then there is a mixture of x lb. water and $(1 - x)$ lb. dry steam.

If supersaturation were complete, $x = o$ and the steam would be undercooled to the full extent, namely $(T_s - T_2)$ where T_s is the saturation temperature and T_2 the temperature corresponding to H_2 and V_2. If reversion were complete x would be the ordinary wetness corresponding to H_2 at P_2. With any intermediate value of x the dry steam present would have volume V cub. ft. per pound, and heat H units per pound, and its temperature would be T, so that the actual undercooling would be $(T_s - T)$, and in these circumstances :—

$$V_2\{1 + y\} = x v + (1 - x) V \quad . \quad . \quad (3)$$

$$H_2 = x h_2 + (1 - x) H \quad . \quad . \quad (4)$$

where v and h_2 are, respectively, liquid volume and heat per pound.

Using the Callendar relation between H and V, equation (4) may be written :—

$$H_2 = xh_2 + (1 - x)\left\{\frac{P_2}{A}(V - c) + B\right\} \quad (5)$$

where a, c and B are constants.

Substituting the value of V from (3) in (5) solving for x and neglecting the small term $(v - c)$ which appears, there results :—

$$x = \frac{P_2 V_2 y}{a(B - h_2)}.$$

But V_2 is the volume after dry expansion with loss. Representing this loss by the factor k as in equation (2), page 833, it can be shown that :—

$$V_2 = \frac{V_1}{r}(k + r^a),$$

in which $r = \frac{P_2}{P_1}$, and $a = \frac{5}{13}$.

Hence :—

$$x = \frac{P_1(k + r^a)}{a(B - h_2)} V_1 y \quad . \quad . \quad . \quad (6)$$

Now if complete reversion had taken place, the water present in each pound of steam would be :—

$$m = \frac{H_s - H_2}{L_2} \quad . \quad . \quad . \quad (7)$$

Fig. 8. FLOW CURVES FOR NOZZLE B_2

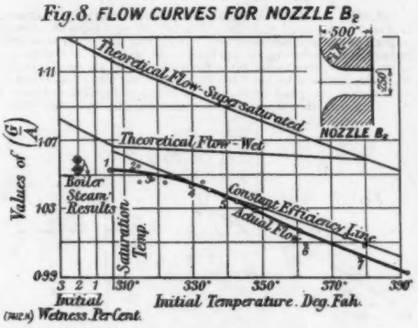
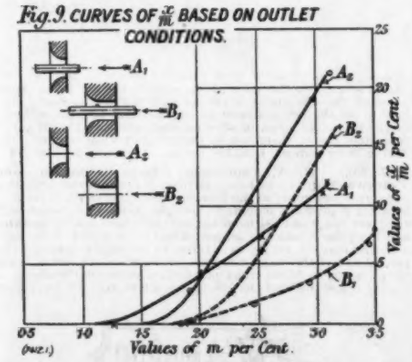


Fig. 9. CURVES OF $\frac{x}{m}$ BASED ON OUTLET CONDITIONS.



where H_s and L_2 are, respectively, the total and latent heats of dry steam at P_2.

But :—

$$H_2 = \frac{P_2}{a}(V_2 - c) + B,$$

or, substituting for V_2 and neglecting c :—

$$H_2 = \frac{P_1 V_1}{a}(k + r^a) + B$$

and by substitution in (7) :—

$$m = \frac{1}{L_2}\left\{(H_s - B) - \frac{P_1}{a}(k + r^a)\right\} \quad . \quad . \quad (8)$$

By dividing (6) by (8) there results :—

$$\frac{x}{m} = \frac{P_1 V_1 (k + r^a) L_2 y}{(B - h_2)\{a(H_s - B) - P_1 V_1 (k + r^a)\}} \quad (9)$$

and the quantity so given may be referred to as the "fractional reversion," and used to indicate the extent of the effect which is being considered. In (9) a and B are constants ordinarily appearing in the Callendar steam equations ; P_1 and V_1 are initial pressure and volume ; h_2, L_2 and H_s are the heat values for dry steam at P_2 ; r is the expansion ratio $\frac{P_2}{P_1}$; y is obtained directly from the diagrams of flow curves, and k is a loss factor implicitly contained in the efficiency value and fully dealt with in previous papers by the authors.

This refractional reversion value can be readily connected with the range of undercooling in the following approximate way :—

From equation (4) above :—

$$H = \frac{H_2 - xh_2}{1 - x},$$

$$\therefore H - H_2 = \left(\frac{x}{1 - x}\right)(H_2 - h_2).$$

If $x = o$, $H = H_2$: if $x = m$, $H = H_s$, hence :—

$$\frac{H - H_2}{H_s - H_2} = \frac{x(1 - m)}{m(1 - x)} \quad . \quad . \quad . \quad (10)$$

Now assuming as reasonable approximations : (1) that within the range T_2 and T_s the specific heat is constant, and (2) that

$$\frac{1 - m}{1 - x} = 1$$

practically ; then :—

$$\frac{T - T_2}{T_s - T_2} = \frac{x}{m}$$

$$\therefore (T_s - T) = (T_s - T_2)\left(1 - \frac{x}{m}\right) \quad . \quad . \quad (11)$$

That is, the actual temperature depression below the saturation value is equal to the product of the theoretical undercooling and the uncompleted reversion.

From equations (9) and (11) the essential results may be shown in a simple manner.

In Fig. 9 the fractional reversion values are given for all the cases on a base of m — the equivalent wetness. In deriving these curves the values of pressure ratio r which have been used are those for the outlet sections of the various nozzles ; and the resulting curves indicate that this process will bear a little further examination. It is seen that the curves for the parallel nozzles B_1 and B_2

Fig. 10. CURVES OF $\frac{x}{m}$ BASED ON "THROAT" CONDITIONS.

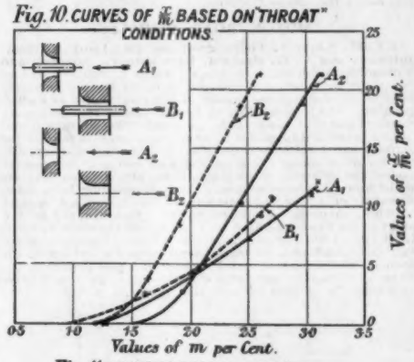
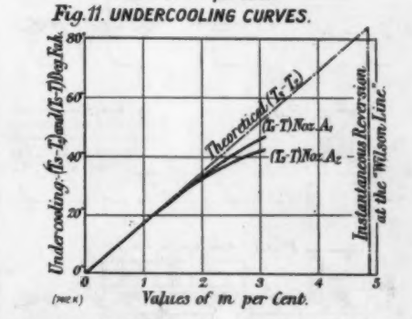


Fig. 11. UNDERCOOLING CURVES.



as so calculated, show smaller reversion effects than the convergent nozzles A_1 and A_2 and at higher values of m ; and this hardly seems sound.

The variation of outlet pressure ratio in all convergent and convergent-parallel nozzles operating on the full range is a real guide to variation of loss in expansion, and therefore to change of flow due to such loss ; but it is not necessarily a guide to flow variations due to supersaturation effects. The mass flow per square inch along a parallel tail piece is constant, and consequently any change might occur in this length without influence on the actual flow curve. It follows, therefore, that the criterion y is only strictly applicable to the up stream end of the parallel length, that is, to the condition at the end of the convergence. Examination of the effect in the tail would involve exact knowledge of otherwise unaccountable pressure changes therein. If it were proved that the pressure ratio curve were invariable over the important initial superheat range, the use of y would be legitimate at any section ; but it would then directly follow that no further reversion took place after the convergent period. Actually, in the short parallel nozzles here employed, the change in the pressure curve is hardly conclusive ; in longer examples it is a shade more definite, but in no case is it great. From this the general fact might be deduced that reversion seems to be rather difficult at the high speeds attained in the parallel outlet lengths, although there the actual rate of expansion is slow. The point is not susceptible of clear proof from the data in hand, and is really outside the scope of the present treatment.

Although the actual flow curves for the B_1 and B_2 nozzles are plotted against theoretical cases based on the outlet ratios, the values of y so obtained will not be radically altered if the "throat" values are used, so that recalculation on this basis may be made directly by use of equation (9). It should be pointed out that the "throat" condition is only accurately known for B_1, namely, $r = 0{\cdot}608$; it has been assumed as $0{\cdot}605$ for B_2, but may be distinctly lower.

The results of this redetermination are shown in Fig. 10, and the quite close agreement reached in the case of A_1 and B_1 seems significant of a correct reading of the anomalous result obtained in Fig. 9. The fact that B_1 gives slightly higher values than A_1 seems reasonable, since there is a smaller expansion range occurring in the same length. The curves for A_2 and B_2 are rather widely separated, but the essential data are not so exactly known.

The net result appears to be that during the rapid expansion in the convergence of a nozzle taking initially dry steam and expanding to a condition equivalent to 3 per cent. wetness, the reversion is about 12 per cent. for the nozzle with central search tube, and somewhat over 20 per cent. for the full bore jet. The difference seems rather unaccountable, but it might be best to accept it as a normal variation in an unstable occurrence.

Using equation (11) and the results for A_1 and A_2, in Fig. 10, the curves of "temperature depression" $(T_s - T)$ may be obtained as shown in Fig. 11. These curves, of course, simply depart from the theoretical by the percentage amounts shown in Fig. 10. The tendency would seem to be towards a maximum undercooling range for the case of rapid expansion ; and this might tentatively be put at between 40 deg. and 50 deg. F. Legitimate continuation of the curves beyond the actual end points attained in these tests could only be made by means of further tests employing initial wetness conditions, and this promises some little difficulties that will be readily appreciated. The line of instantaneous reversion at the "Wilson" limit is roughly indicated in Fig. 11, but that such a condition is actually possible will be doubted. Although curves of temperature depression may reach a maximum before, and have a falling slope at this place, it seems reasonable to believe that a certain amount of undercooling will persist beyond it. It will be noticed that there is no indication of reversion before a value of, roughly, 1¼ per cent. equivalent wetness is reached. This is, in general, borne out by tests at high back pressure which do not show the typical flattening at the top of the flow curves.

On the whole the investigation deals with small effects, and may create doubts because of that ; but it must be admitted that the data, so far as they go, indicate partial reversion during the rapid expansion at the inlet of convergent nozzles, and at conditions well within the "Wilson" limit ; and do so by means of the evidence that provides the main substantiation of the general hypothesis.

THE RECOVERY OF BENZENE BY MEANS OF CHARCOAL.—Several papers have been written during the last year on the Bayer process of recovering solvents like benzene, carbon disulphide, ethylene, &c., from solutions used in various important industries, as well as from coke oven gas, by means of "activated" charcoal. The Bayer Farbenfabriken of Leverkusen, are activating charcoal by carbonising wood in the presence of zinc chloride and other salts at 1,000 deg. C., and they claim thus to obtain a charcoal which, as regards benzene, is 20 times as active as ordinary charcoal. The regeneration of the charcoal is effected by means of dry steam at 180 deg. C. In the laboratory the Bayer method is already used to a considerable extent. Coke-oven works wash the gas with some oil to strip it of its benzene, and the technical substitution of activated charcoal for oil is so far only being tried. The two processes, washing with oil and adsorption by charcoal, are entirely different. The former process relies upon the solubility of benzene in the oil, the second on surface adsorption.

PYROPHOROUS BLAST-FURNACE DUST.—The dust collecting in the upper portions of the shafts of blast furnaces and in the filter bags of dry gas purifiers is apt to catch fire spontaneously or when disturbed. At Wissen in Westphalia it was observed that the dust heaps would begin to smoulder in a few hours or days, especially heaps of very fine dust settling at some distance from the furnace. The still finer filter bag dust, weighing only about a quarter of the coarser blast-furnace dust, was worst, and the men had to be very quick and keep the gas suction going, when exchanging the gas bags, to prevent the bags from catching fire. The investigation started at Wissen on behalf of the Blast-Furnace Section of German Iron Men, on which J. W. Gilles reported in *Stahl und Eisen*, of June 8, pages 884 to 891, is not complete yet ; but it shows that two substances are mainly responsible. The dust contained neither metallic iron (to be removed by magnets), nor metallic zinc, nor was it rich in carbon. But it was rich in manganous oxide, and at Burbach and Neuenkirchen (Saar district), where similar trouble had been experienced, rich in ferrous oxide ; both these protoxides are known to be pyrophorous. Sulphides present in the dust do not seem to be concerned in the phenomenon, nor had the potash any influence, though the whole mass might become hot when the potash absorbed moisture. When the dust is once allowed to cool under exclusion of the air, it will not catch fire readily afterwards until heated up ; but old dust heaps need only be stirred up with the shovel to begin to glow. The temperature to start ignition seems to range from 167 deg. C. (fresh dust) up to 120 deg. C. (old dust). When the dust is heated in the presence of air so that the carbon is burnt out, and then cooled, and reheated in a current of hydrogen or of illuminating gas, it proves highly pyrophorous. This treatment would result in the formation of protoxides of iron and manganese, and it is owing to their presence that the original bluish colour of the dust turns reddish brown as it glows ; unpleasant fumes are liberated during this spontaneous combustion. In some works the trouble has vanished and reappeared with changes in the ores and in their manganese contents. At Neuenkirchen the dust, which is sold as fertiliser, has to be stored in sealed tins.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

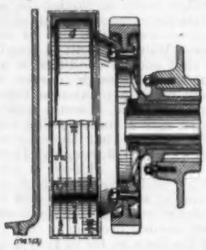
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

GAS ENGINES, PRODUCERS, HOLDERS, &c.

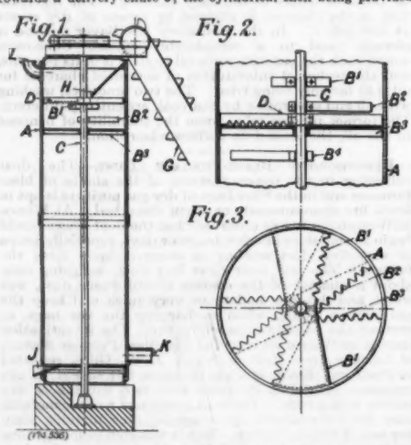
174,753. W. Shackleton, Tinsley, Sheffield, and Sheffield Simplex, Limited, Tinsley, Sheffield. Internal-Combustion Engines. (1 *Fig.*) November 3, 1920.—This invention provides means whereby, particularly in the case of a multi-cylinder engine, the position and nature of the stroke of each piston at any moment can be ascertained. The invention comprises, for a single or multi-cylinder engine, a rotatable



member 4, such as a cylindrical drum, which is driven by the engine to rotate at an angular velocity equal to that of the crankshaft, or an even multiple or sub-multiple thereof, and which bears on it, as for example, on the cylindrical wall of the drum, markings which will, in co-operation with an index or datum line, indicate the position and nature of the stroke of each piston in its cylinder. (*Sealed.*)

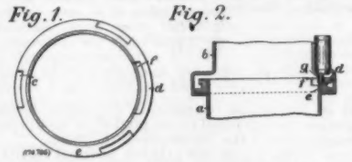
MINING, METALLURGY AND METAL-WORKING.

174,536. D. Harvie, Rutherglen, and D. Harvie, Rutherglen. Wet Coal Dryer. (3 *Figs.*) September 5, 1920—This invention relates to apparatus for drying coal of the type comprising a cylindrical shell A disposed with its axis vertical and fitted internally with a helically-spaced series of platforms B^1, B^2, B^3, B^4, on to which the coal is fed by a conveyor G. And a rotary shaft C disposed axially of the shell and provided with arms D arranged to sweep the platform so that the coal is constrained to pass downwardly from one platform to the other towards a delivery chute J, the cylindrical shell being provided



at the base with an inlet pipe K for heated air and being formed at the upper end with an outlet pipe L for discharge of the air containing the moisture removed from the coal in the passage of the air through the shell. The invention is characterised by the feature that the sweeping edge of one side of each arm D is formed with serrations presenting, in effect, a rake which serves to spread the coal on the platform while the lower edge of the other side of each arm is formed plane so as to sweep from the platform the coal spread by the serrations. (*Sealed.*)

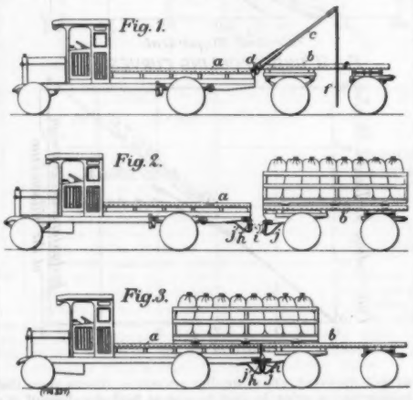
174,706. The Thor Electric Safety Lamp Company, Limited, Birmingham, and T. Stretton, Birmingham. Miners' Safety Lamps. (2 *Figs.*) October 27, 1920.—This invention relates to magnetically-released locks for miners' safety lamps. The invention is especially applicable to a usual form of cell container *a* carrying externally and integrally at its upper end a ring *e* having two parallel outwardly-protruding flanges serving to form a channel between, and in which the uppermost flange *d* is interrupted at intervals by means of recesses *c* in determined positions so that on the container *a* being inserted into the cavity beneath the lamp top *b*, lugs secured



to the lamp top and provided in correspondingly determined positions enter the recesses *c*, and on the partial rotation of the container with respect to the lamp top, the lugs pass into the channel, and the upper flange *d* then serves to carry the container from the lamp top. Various methods are known of rendering the lock inaccessible from without and incapable of being tampered with by the use of a bent pin or wire, and the invention consists in providing the slot or recess *f* in the top of the cell container *a* open at the inside and at the top for the reception of the end of the locking bolt *g* so that the locking bolt is exposed to the inside and not to the outside. (*Sealed.*)

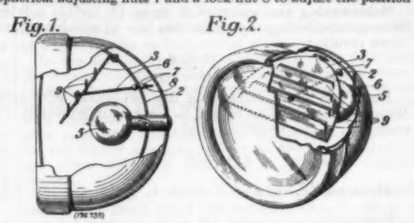
MOTOR ROAD VEHICLES.

174,537. John I. Thornycroft and Co., Limited, Westminster, and V. G. Barford, Basingstoke. Loading and Unloading Vehicles. (13 *Figs.*) March 1, 1921.—It is now frequently the practice to transport goods by loading them into or on to wheeled supports capable of being transferred as a whole from one vehicle to another or from a vehicle to a stationary platform and *vice versâ*. The principal difficulty experienced in this mode of transport is to secure coincidence in level of the surfaces across which the transference is to be effected. Broadly the invention consists of a form of lever coupling between the bodies, the surfaces of which if not already at a common level, are to be brought into coincidence, the lever coupling being hand operated, or acting automatically as the bodies are brought together. Assuming, as shown in Fig. 1, that a motor lorry *a* and a trailer *b* are being dealt with, then a simple arrangement is to fit the trailer *b* at each side with a lever *c* having a slotted extremity *d* adapted to engage a pin upon the vehicle *a*, the arrangement being such that by means of a pull applied to the levers *c*, it may be through a flexible connection *f*, a relative adjustment is effected between the platforms of both vehicles



in a vertical direction, whereupon a load can be easily wheeled from one to the other. In the case where adjustment in level takes place automatically in accordance with decrease in distance between the vehicles, each vehicle, as shown in Figs. 2 and 3, is provided with a pair of links, lettered *h* on lorry *a* and *i* on trailer *b*, adapted to be connected temporarily together when the vehicles are sufficiently separated from one another to enable the links to be fitted into the dotted position shown in Fig. 2 so as to constitute a pair of toggle lever combinations which, as the distance between the vehicles is decreased, produces the required relative vertical movement of the bodies of the vehicles. This arrangement can be operated by first chocking the wheels of the trailer and then, after coupling the links *h*, *i*, backing the lorry into engagement with the trailer, subsequently braking or chocking the lorry. The vehicles will then be as represented in Fig. 3, which figure shows the load in the process of being transferred from the trailer to the lorry. To lessen shock, each vehicle may be fitted with a bracket *j* of a more or less resilient character adapted to be engaged by the temporarily coupled ends of the toggle levers. (*Accepted February* 8, 1922.)

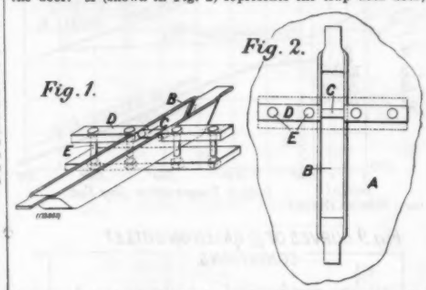
174,738. S. Day, Great Missenden. Dimming Devices for Headlamps. (2 *Figs.*) November 2, 1920.—This invention relates to dimming devices for road vehicle lamps of the type which includes an adjustable screen extending transversely across the width of the lamp to obstruct the light passing from the upper portion of the latter and means to adjust the lower edge of the screen. According to this invention, a dimming device of this type comprises a screen 3 which lies wholly within the lamp casing and is hinged therein by its upper edge, with the lower edge of the screen lying in an approximately horizontal plane passing through the axis of the lamp 5, and a screwed rod 6 having spherical adjusting nuts 7 and a lock-nut 8 to adjust the position



at which the reflector hangs from its hinge. By this adjustment the height of the beam of light from the lamp can be raised or lowered. Preferably the screen is hinged to the reflector 2 at a position well within the cavity thereof. The screen may be formed as either a plain sheet of opaque or translucent material, or as a sheet of material having louvres 9 formed in it to permit a certain amount of light to pass from the lamp bulb to the upper part of the reflector. (*Sealed.*)

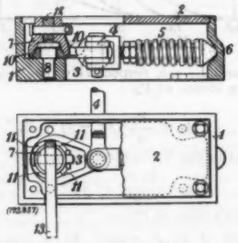
RAILWAYS AND TRAMWAYS.

173,955. C. J. H. McRea, Mill Hill. Railway Wagons. (2 *Figs.*) December 4, 1920.—This invention relates to railway wagons of the kind adapted for carrying coal and other materials in bulk. In such wagons the trap doors are provided with one or more countersunk cups fitted flush with the upper surface of the floor and provided with a fixed cross-bar with which the trimmer may engage the point of his pick or other tool and thereby raise the door. A (shown in Fig. 2) represents the trap door floor,



B is the cup and C is the fixed cross-bar therein. D, D are side plates secured to the sides of the cup B, and E, E are bolts whereby the side plates D are secured to the trap door. The cup B and the side plates D are countersunk into the material of the trap door so as to offer no obstruction to the shovel or other tool passed thereover by the trimmer when removing the coal or other material from the bottom of the wagon. (*Sealed.*)

173,857. H. A. Thompson, Glasgow. Railway and Tramway Points. (4 *Figs.*) October 7, 1920.—Point-operating apparatus, according to this invention, comprises a metal casing 1 in which is pivotally mounted a straight crank 3 to connect with the point rod 4 and also move against the action of an adjustable helical spring 5 which is supported in the casing at 6 to form with the crank a toggle mechanism to throw the points. The pivotal end of the crank 3 is connected with a cylindrical head-piece 7 made to fit the crank pivot pin 8 housed in the casing 1, the top end of the head piece turning in a hole drilled in the casing



lid 2. Connection is made between the head-piece 7 and crank 3 by means of segmental projection or stops 10, 11 cast on each member. The top of the head-piece is gapped to form a hinge 12 with an operating handle 13 pivoted at its end so as to be free to fall to or be raised from the horizontal rest position. The slope of the handle when raised to operate the points is about 45 deg. with the horizontal. The function of the stops 10, 11 on the crank 3 and head-piece 7 is to provide a limited relative movement between these members and enable the points to be hand operated, and also to provide a still handle when the points are run through trailing. (*Sealed.*)

THE END OF THE ONE HUNDRED AND THIRTEENTH VOLUME.

Assistant Engineer Required for Public Works in Chile.—Write, stating age, married or single, experience, salary required, to BOX B.24, WILLINGS, 119, Moorgate, E.C.2. U 590

Wanted for the Middle East, a CAPABLE ENGINEER, experience with Internal Combustion Engines essential.
Must be unmarried and total abstainer, age not over 30 years. Apply in own handwriting, stating where educated and recounting training and experience.
Copies only of testimonials to be enclosed.
Address, U 588, Offices of ENGINEERING.

Wanted, an Electrical ENGINEER for large iron and steel works near the East Coast. Applicants must be thoroughly experienced in the maintenance and upkeep of all plant and appurtenances connected with generating and transmitting power for all purposes, and be conversant with the most economic and up-to-date methods of running the whole of the electrical equipment. Suitable house available. Applications, giving age, experience and salary required, together with recent references.—Address, U 538, Offices of ENGINEERING.

The Services of a Competent GENTLEMAN are REQUIRED for the post of CHIEF ENGINEER at a large iron and steel works near the East Coast. In making the selection preference will be given to men who have had thoroughly practical experience in the economic running of sheet bar mills. Applicants should also have had experience in modern coke oven, blast furnace and steel furnace design and maintenance, as well as all auxiliary plant appertaining thereto. Only thoroughly live men need apply. Suitable house available. Applications, giving age, experience and salary required, together with recent references.—Address, U 539, Offices of ENGINEERING.

First-class All British Ball Bearing Makers, with good connection, who wish to extend, have several DISTRICTS OPEN for AGENTS who can influence business. All replies treated in confidence.—Address, U 570, Offices of ENGINEERING.

Wanted, at Once, First-class DRAUGHTSMAN thoroughly experienced in the design of all sizes of Electric Cranes. Preference given to one who has had considerable practice in estimating. State age, experience and salary required.—Address, U 549, Offices of ENGINEERING.

Wanted, Chief Draughtsman by Firm of General Engineers in the Midlands, accustomed to control of Office routine and experienced in Hydraulic and General Engineering.—Address, stating age, experience and salary required, U 548, Offices of ENGINEERING.

Draughtsman. — Wanted, on N.E. Coast, in large Constructional Works, FIRST-CLASS DRAUGHTSMAN, with latest modern blast furnace experience. No application except from men with this experience will be considered. Good wages to right man.—Address, U 498, Offices of ENGINEERING.

A Firm of Constructional Engineers REQUIRE the SERVICES of a FIRST-CLASS DESIGNER, with workshop experience, capable of taking full charge of designing and estimating departments. Please state age, salary required, and give details of previous experience. None but those having held similar positions need apply.—Address, U 572, Offices of ENGINEERING.

Wanted, Designing Draughtsman, capable of developing new line of Centrifugal Pumps. Must be technically trained and capable of assuming full charge of work. Location, Lancashire. State age, education, practical experience and salary expected.—Address, U 534, Offices of ENGINEERING.

Draughtsman Required for the Bombay Office of a British Firm of Constructional Engineers. Must have wide experience in the design of constructional steelwork, including steel frame buildings, bridges, etc., with good technical training and works experience. Age 28–36, preferably single. Salary Rs. 750 per month. Free passage out and home, under agreement for three years minimum.—Address, stating age and detailed experience, U 624, Offices of ENGINEERING.

Draughtsman, with thorough knowledge of light Electrical Truck and Hoist design REQUIRED by Works near London. A man with practical knowledge of light internal combustion engines would be preferred, but sound electrical knowledge, combined with thorough constructional ability, experience in modern machine shop practice and economical production is essential.—Address, stating experience, salary required, copies of testimonials, etc., U 623, Offices of ENGINEERING.

METROPOLITAN WATER BOARD.

TEMPORARY CIVIL ENGINEERING AND ARCHITECTURAL DRAUGHTSMEN.

The Metropolitan Water Board require the

Services of a Thoroughly Experienced, Neat and Expeditious CIVIL ENGINEERING DRAUGHTSMAN, accustomed to the preparation of drawings customary in a waterworks undertaking. They also require a thoroughly Competent and Experienced ARCHITECTURAL DRAUGHTSMAN. The appointments will be held during the pleasure of the Board, at inclusive Salaries at the rate of £350 per annum each.
Applications, stating age and particulars of experience, may be sent to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery Avenue, E.C. 1," not later than Saturday, 8th July, 1922, endorsed "Civil Engineering, or Architectural Draughtsman" (as the case may be). Candidates selected for interview will be required to produce specimens of their work. The appointments are determinable by one month's notice on either side, but without prejudice it is expected that the engagements will continue for a year.
W. MOON,
Offices of the Board, Clerk of the Board.
173, Rosebery Avenue, E.C. 1.
23rd June, 1922. U 59

The Broadway Engineering Handbooks. NARROW CROWN 8vo (Pocket Size).
Volume XIV.

LATHES
THEIR CONSTRUCTION AND OPERATION.

By G. W. BURLEY, Wh.Ex., A.M.I.Mech.E.

344 Pages. Price 4s. 6d. net (post free, 4s. 11d. home and abroad). Cash with Order.

Catalogue, giving full Contents of this volume, sent post free on application to 9633

SCOTT, GREENWOOD & SON, 8, Broadway, Ludgate, London, E.C. 4.

Just out. Royal 8vo. Fully Illustrated. Price 30s. net.

AN INTRODUCTION TO THE STUDY OF

Metallography and Macrography

By Professors LÉON GUILLET and ALBERT PORTEVIN

Translated by LEONARD TAVERNER, A.R.S.M., D.I.C., with an Introduction by Professor H. C. H. CARPENTER, F.R.S.

"The authors have succeeded in producing a work which is remarkable for the completeness with which the principles involved in the study are laid down; and in addition to the principles, they have also included a comprehensive survey of the applications of these principles to the metals, ferrous and non-ferrous, used in industry. . . . . To engineers desiring a sound working knowledge of the metals they work and use, the book can be well recommended."—*Times Engineering Supplement.*

"It is impossible in a short review to do adequate justice to the vast mass of information contained in these chapters, which more than ever emphasise the practical application of theory, and which at the same time reveal the great amount of original work effected by the writers. . . . . A remarkable book, remarkably well written, translated and produced."
—*Mining Journal.*

Write for Illustrated Prospectus to U 573

G. BELL & SONS, LTD., Portugal St., London, W.C. 2.

Reinforced Concrete Firm of Engineers and Contractors REQUIRE JUNIOR DRAUGHTSMAN with some years experience. Must be neat tracer and capable of simple calculations.—Address, U 576, Offices of ENGINEERING.

Draughtsman Required. North-East Coast. Must be thoroughly competent on all classes of structural work and bridge work. Age 30 to 40. Full particulars, stating salary required.—Address, U 559, Offices of ENGINEERING.

Leading Draughtsman REQUIRED by Aerial Ropeway Specialists. Must be thoroughly experienced. Good prospects for suitable man. State full particulars of experience, salary required, &c.—Address, U 526, Offices of ENGINEERING.

An Old Established Firm of Electrical and Mechanical Engineers REQUIRE the SERVICES of a FIRST-CLASS D.C. AND A.C. MOTOR DESIGNER, and with Mechanical Design experience.
To a first-class man who could supervise works, and work on up-to-date lines this job would be of a progressive character. A man who is prepared to adapt, and cultivate team work would be appreciated and liberally treated.—Address, U 582, Offices of ENGINEERING.

Foundry Foreman for London Ironfoundry.
Must be a good practical moulder and used to control of men.
Address, stating age, experience and salary required, U 620, Offices of ENGINEERING.

Civil Engineer Holding Important public appointment, has a VACANCY for a PREMIUM PUPIL.—751, *Yorkshire Post*, Whitefriargate, Hull. U 626

SITUATIONS WANTED.

Buyer.—The Manager of a large Engineering Works' Purchasing Department, who has an exceptionally wide knowledge of the Markets of the Country, DESIRES to Negotiate NEW APPOINTMENT.—Write, Z.M. 612, care of DEACON'S, Leadenhall Street, E.C. 3. U 629

Works Manager, M.I.Mech.E. M.I.A.E., DESIRES RESPONSIBLE POSITION; wide experience in General Engineering, Motor Car Construction and Aeronautical work. Would invest capital if necessary.—Address, U 626, Offices of ENGINEERING.

Civil Engineer (38), Experience survey, construction, and maintenance railways, South America and the East, SEEKS POST anywhere, technical or commercial. B.Sc., A.M.I.C.E. Good French and Spanish, some Arabic. —Address, U 607, Offices of ENGINEERING.

Engineer Seeks Position of permanent character in good firm of consulting marine engineers. Holds B.O.T. Chief Engineer's Certificate. Has had experience in Diesel work. Supervision of repairs to Machinery, Boilers and Ships, and since October 1919, has represented a firm of consulting marine engineers on the Continent. Willing to invest capital. — Address, U 603, Offices of ENGINEERING.

A Young Engineer, Student I.C.E., DESIRES a POSITION as Assistant to Civil Engineer. Six years' apprenticeship with Messrs. Vickers; general workshop and office experience, trained in technical subjects.—Address, U 493, Offices of ENGINEERING.

Engineer, 32, Desires Post as Assistant Chief or Works Foreman in factory or works, held similar staff positions for 10 years.—Address, U 541, Offices of ENGINEERING.

Young, Energetic Engineer, with good education and exceptional theoretical and practical experience, DESIRES POSITION in any capacity with opportunities of advancement. Just completed three yrs. as inspector with well-known firm. First-class references of ability and training.—U 600, Offices of ENGINEERING.

Civil Engineer (26), unmarried, commissioned war service (R.E.), passed A.M.I.C.E. exams., apprenticeship served in waterworks engineer's office, DESIRES SITUATION.—Address, U 556, Offices of ENGINEERING.

B.Sc. Eng. (Lond.), Ex-Officer, 2½ years electrical shops and test-bed, Requires Technical or Design Appointment. Refs. —Address, U 521, Offices of ENGINEERING.

A. C.G.I. (C. & M.), A.M.I.C.E. (38), 16 years' service P.W.D. India, Seeks Employment in any suitable capacity near London. —Address, U 593, Offices of ENGINEERING.

Stockkeeper and Stockyard Foreman (Constructional Engs.) Seeks Position. 20 years' experience. Can take off quantities. Knowledge of office work, timekeeping and assist costing.—Address, U 594, Offices of ENGINEERING.

Advertiser Seeks Permanency as Foreman-in-Charge, Maintenance or Erection; 15 years' experience in maintenance and erection of Steam Feed, Water, Hydro and Boilers. 10 years Foreman-in-Charge, home and abroad. Non-union. Good organiser. 12 months on board experience.—Address, U 550, Offices of ENGINEERING.

Draughtsman (21), Seeks Situation in D.O. Seven years' experience in General Engineering and Furnace Construction, good references.—M.C.S., 205, Links Road, S.W. 17. U 558

Secretary to Engineer (Lady, 30), shorthand, typing, filing, costs, some French. Held similar position. References. Willing to go anywhere in England or abroad.—Address, U 627, Offices of ENGINEERING.

PARTNERSHIPS

Engineering Partnerships AND BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street,
LONDON, E.C. 4.
ESTABLISHED SEVENTY YEARS. 9055

Partnerships, Directorships, WANTED in really well-established businesses in town and country, for £2,000 to £15,000. List of investors for June sent. Investments of all kinds dealt with. OFFICERS' PARTNERSHIP GUARDIAN, 116, Victoria Street, S.W. 1. FOR ALL EDUCATED MEN. Call. U581

Engineer Required with £3500 for half share freehold Metal Spinning and Enamelling Works, London; can expect at least £1000 p.a. Investigation invited.—Particulars from ARNOLD & CO. (LONDON), LTD., 148, Cannon St., E.C. 4. U 560

PATENT AGENTS.

Patents DESIGNS AND TRADE MARKS IN ALL COUNTRIES.
E. P. Alexander & Son,
CHARTERED PATENT AGENTS,
306, HIGH HOLBORN, LONDON, W.C.
(Established 1874.)
Telephone: Central 7434. CM 585

S. Sokal, CHARTERED PATENT AGENT.
1, Great James Street, Bedford Row, London, W.C.1.
T.N. 4515 Museum. 9075

WANTED, &c.

Rosser and Russell, Ltd., MECHANICAL ENGINEERS,
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
Phone: Hammersmith 31, 967. 9311

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported Upon. Over 26 years' experience. Tel.: 736 and 737 Stratford. Wire: "Rapidising, London." —Great Eastern Road, Stratford, E.15. 1794

For Your Repairs or any SPECIAL MACHINERY, try—
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Battersea, S.W. 11.
Est. 1854. 766

Repetition Work Wanted for High Class Plant, including Precision Boring Mills, Automatic and Capstan Lathes, Cylinder and Precision Grinders, Case-hardening and Heat Treatment.
Accuracy and high quality finish guaranteed.
W. & F. WILLS, LTD., Bridgwater. 9743

Important Foundry Can Carry OUT CASTINGS, both Iron and Steel, in large series, machine moulded. Can also cast pieces up to 30 tons in weight. Any castings, iron, steel, brass and all special alloys undertaken.
Address:
SOCIETE DE PRODUITS METALLURGIQUES,
143, Boulevard Haussmann, à Paris(8e).
A Few Agents Required. 9678

For all Classes of Drawing, TRACING AND PHOTO PRINTING, send your orders and enquiries to the North West Drawing Office, 2, High St., Harlesden, London, N.W. 10. U 442

Substantial Engineering Firm REQUIRED to undertake 10 years' contract, manufacturing special (heavy to medium) plant. Orders waiting. Usual foundry and machine shop equipment, with few thousand pounds available capital required to carry through successfully.—Address, U 568, Offices of ENGINEERING.

Representation. — A Well-known Firm of Engineers and Exporters with connections in South Africa and Offices in Westminster would be PLEASED to ACT as AGENTS for Engineering Firms desirous of extending their business.—Address, U 326, Offices of ENGINEERING.

Experienced Mechanical and Electrical Engineers with Office in the centre of Manchester, are PREPARED to act as SALESMEN or AGENTS for one or two engineering specialities or materials. Good connection in Lancashire with Engineering Companies.—COOPER and JONES, Consulting Engineers, 28, Deansgate, Manchester. U 554

TO MANUFACTURERS OF ORE ROASTING FURNACES.

The Proprietors of Patent No. 9958 of 1915, are DESIROUS of ENTERING into NEGOTIATIONS for the grant of licences to manufacturers on royalty or otherwise, or to treat for the sale of the Patent outright.—Particulars will be furnished on application by A. M. & WM. CLARK, 53 and 54, Chancery Lane, London, W.C. 2. U 501

The Proprietors of Patent No. 125964, and Addition (No. 140039), Ateliers Rorive, for "Automatic Stopping Device for Pneumatic Hammer-drills and other Pneumatic Tools," are ANXIOUS to ENTER into NEGOTIATIONS with a Firm or Firms for the grant of Licences on reasonable terms or to treat for the sale of the Patent outright.
Full particulars can be obtained on application to:—
J. S. WITHERS & SPOONER,
Chartered Patent Agents,
51-52, Chancery Lane,
London, W.C. 2. U 605

The Proprietor of Patent No. 126710, C. S. Heaslee, for "Improvements in and relating to Submarine and Mine Destroying Devices," is ANXIOUS to ENTER into NEGOTIATIONS with a Firm or Firms for the grant of Licenses on reasonable terms or to treat for the sale of the Patent outright.
Full particulars can be obtained on application to:—
J. S. WITHERS & SPOONER, U 606
Chartered Patent Agents,
51-52, Chancery Lane,
London, W.C. 2.

The Proprietor of the Patent No. 108355 for "Assorting Apparatus," is DESIROUS of ENTERING into ARRANGEMENTS by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to:—
HASELTINE, LAKE & CO.,
Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C. 2. U 618

Wanted, &c., continued on page 4.

The Proprietors of British Patent No. 172119, dated 4th June, 1918, for "Improvements in or relating to Retort Charging Machines," are DESIROUS of ENTERING into NEGOTIATIONS for the exploitation of the invention in Great Britain.
For particulars apply, NEWBURN ELLIS & CO., of 70/72, Chancery Lane, London, W.C. 2. U 616

Wanted Offers for New Ideas in Petrol and Steam Turbines, &c.
B. WATERHOUSE, 5, Rockstone Road, Bassett, Southampton. U 625

Drawings and Tracings of all description PREPARED quickly and cheaply.—E. L. COMFORT & SONS, 31, West Park Road, Kew, Surrey. 750

Agents Wanted for British Colonies by first-class Swiss factory of Modern Woodworking Machinery.
Write:—
No. Z.N. 1613 to
RUDOLF MOSSE,
Publishing Agency,
Zurich. U 496

Agents Wanted to Sell High class Belt Paste, suitable for all types of driving belts, in the following centres—old established firms supplying engineers' stores and with good connection essential:—Bristol, Cardiff, Birmingham, Manchester, Chester, Glasgow, Belfast, Carnarvon, Liverpool, Derby, Sheffield, Stoke, Nottingham, Bradford, Leicester, Ipswich, Edinburgh, Dublin, York, Hull, Durham, Lincoln, Newcastle, Sunderland, Carlisle, Aberdeen, Inverness, Cork, Portsmouth, Devonport, Brighton.—Address, U 575, Offices of ENGINEERING.

A High-Grade American Corporation, long established and well financed, employing about 80 men, would consider taking over the American Manufacturing Rights for suitable medium weight or heavy machinery—Textile, Hydraulic, Rubber, Printing, Rope Making, etc. None but well-founded responsible concerns of good standing will be considered.—STOCKER, 22, Yew Street, Nr. Broughton, Manchester. U 622

Wanted Address of Firms supplying apparatus for repairing large steel oil drums.—Address, U 563, Offices of ENGINEERING.

Horizontal Compound Steam ENGINE WANTED, Cylinders about 16 in. and 34 in. dia. by 3 ft. 6 in. stroke, pressure 120 lb. —Reply giving full particulars and price to BOX H, Messrs. W. H. SMITH & SON, 53, Lichfield Street, Wolverhampton. U 619

Wanted, Ammonia Compression REFRIGERATOR, minimum capacity, 24 tons ice making per 24 hours. Steam or motor driven (steam pressure 100 lbs. per sq. inch or voltage 220 D.C.). State full particulars, price, makers, place of inspection.—Address, U 416, Offices of ENGINEERING.

Wanted.—No. 16 Blanchard BELT DRIVEN GRINDER required; state condition and lowest price.—Address, U 591, Offices of ENGINEERING.

Wanted, a 42 in. or 54 in. Bullard VERTICAL TURRET LATHE, with side head. Give full particulars of condition, price and where seen.—Address, U 597, Offices of ENGINEERING.

Wanted, One Belt-Driven HIGH PRESSURE SUCTION FAN, capacity 1800 to 1800 cub. ft. free air per minute against total suction and discharge head of 20 in. water gauge. Also One Belt Driven HIGH PRESSURE SUCTION FAN, capacity 10,000 to 13,000 cub. ft. free air per minute, highest possible suction and discharge head. Full particulars, price, and where fans may be inspected. —Address, U 583, Offices of ENGINEERING.

AUCTION SALES.

Wheatley Kirk, Price & Co. (Established 1850).
Valuers
AND AUCTIONEERS OF 9955
ENGINEERING WORKS PLANT AND STOCK.
46, WATLING STREET, LONDON, E.C. 4.
16, ALBERT SQ. 26, COLLINGWOOD ST.,
MANCHESTER. NEWCASTLE-ON-TYNE.
Telephones & Telegrams at each Address.

G. R.
BY DIRECTION OF THE DISPOSAL AND LIQUIDATION COMMISSION
(PLANT AND MACHINERY SECTION).
At the
GOVERNMENT ROLLING MILLS,
SOUTHAMPTON,
Messrs.

Fuller, Horsey, Sons & Cassell will SELL by AUCTION in Lots on the Premises on TUESDAY, 25th JULY, 1922, and following days,
ROLLING MILL PLANT AND MACHINERY for rolling Cupro-Nickel, Brass, Zinc and Copper Strips and Blanks, including
14 ELECTRICALLY DRIVEN ROLLING MILLS as under:—
One FIVE SET TRAIN by Robinson, 24 in. dia. by 42 in. wide to 20 in. dia. by 30 in. wide, with 750 HP., A.C. Motor by B.T.H.
One EIGHT SET TRAIN 20 in. dia. by 30 in. wide to 18 in. dia. 20 in. wide.
One EIGHT SET TRAIN 15 in. dia. by 15 in. wide to 13 in. dia. 12 in. wide.
Three TWO SET TRAINS 13 in. dia. 13 in. wide, with B.T.H. 50 H.P. Motors.
Eight TWO SET TRAINS 8 in. dia. 8 in. wide, with B.T.H. 40 H.P. Motors.
Forty-four Taylor & Challen Cutting and Cupping Presses.
Six Sutcliffe-Speakman "Emperor" Forging Presses.
Eighty-two Wright 240 lb. Crucible Furnaces.
Fifty-six Wright 800 lb. Tilting Crucible Furnaces.
Hydraulic Scrap Press.
Magnetic Separators.
Pickling Vats and Tanks.
Two Buckton Shearing Machines, Tangye Hydraulic Wheel Press.
Muffle Furnaces. Muffle Charging Machines.
Reavell Motor-driven Turbo Compressors.
Sheet Shearing and Slitting Machines.
Three 5-ton Electric Overhead Travellers, 68 ft. and 80 ft. span.
Two Appleby Electric Jib Cranes. Grafton 5-ton Steam Crane.
ENGINEERS' MACHINE TOOLS,
including two Redman Planing Machines.
Radial and Vertical Drilling Machines.
Two Stirk 16-in. Screw-cutting Lathes.
Ten Screw-cutting and Capstan Lathes, various.
Campbells & Hunter 14-in. Slotting Machine.
Kearn No. 2 Horizontal Boring and Facing Machine.
De Bergue Punching and Shearing Machines.
Brown & Sharpe and Churchill Plain and Surface Grinders.
MISCELLANEOUS PLANT,
including Mason Stone Crusher, Mortar Mills, 36 in. Circular Saw Bench, 24 in. Band Saw, Scrap Metal Conveyors and Elevators.
Manning-Wardle 8½-in. Standard Gauge Loco, narrow gauge Track, 24 in. gauge side tip Wagons.
ELECTRIC POWER PLANT, including
THIRTY 3-PHASE MOTORS
440 volts, 50 periods, up to 80 horse power.
May be viewed by Orders to be obtained of Messrs. FULLER, HORSEY & CO., Mechanical Auctioneers and Valuers, 11, Billiter Square, London, E.C. 3. U 601

G. R.
BY DIRECTION OF THE DISPOSAL BOARD.
SALE BY AUCTION OF
VALUABLE PLANT AND MACHINERY
At the CENTRAL ORDNANCE DEPOT,
CHILWELL, NOTTS.
On TUESDAY and WEDNESDAY, JULY 11th and 12th, at Eleven a.m., each day.
Comprising:—
Eleven MOTOR GENERATORS, 16, 24 and 30 Kw., 73 SINGER'S SEWING AND DARNING MACHINES, 19 ROTARY WASHING MACHINES AND HYDROS, 130 PORTABLE AIR COMPRESSORS, by Reavell & Co., Ipswich, VERTICAL BOILER, 4 ft. 3 in. by 11 ft. 3 in. high, Two TELEGRAPH DUPLEX SETS WITH RELAYS, 684 WIRELESS INSTRUMENTS, 400 TELEPHONE SETS, 330 D.H. TELEPHONE RECEIVERS, 50 TELEPHONE EXCHANGE BOARDS, Four WATCHMAKER'S LATHES, 2560 Buzzer Unit Instruments, 20,000 Double Hook Insulators, 180,000 Telegraph Bolts and Insulators, 2000 Battery Boxes, Switchboards, Cable Reels, Telephone Screens, Galvanometers, 34,000 Miles of Telephone Cable, 500 Kw. TURBINE GENERATING SET, 230 volts, 2200 amps., complete with Condensing Plant and Switchboard, 17-TON WAGON HOIST and TIPPING TRAY CONVEYOR, CLINKER CONVEYOR, STEAM DRIVEN HYDRAULIC PUMP, 26 OVERHEAD CRANES, JIB AND CROSS TRAVERSE 6 ft. 9 in., 16 ft. 6 in., 47 ft. 8 in. Spans, Fans, Signal Lamps, 198 Wagons, Limbers and Carts, 1166 Floor Trucks, Telegraph Poles, Insulated Copper Cable, Ebonite Insulators, Six Electric Searchlights on Carriages, Four Howitzer Mountings on Rail Trucks, Semi-Rotary Pumps, Well Pumps, Hose Piping, Spanners, Road Scrapers, Road Jumpers, Dog Spikes, Sawyers Dogs, Oxygenite, Petrol Cylinders, Pistons and Spare Parts, Microphone Capsules, NATURAL DRAUGHT COOLING TOWER, 70 feet high, capacity 312,000 gallons of water per hour from 95 to 80 degrees Fah., Two VERTICAL DIRECT ACTING BOILER FEED PUMPS, capacity 6000 gallons per hour against 160 lbs. per sq. inch.
On View by Catalogue only, Thursday, Friday and Monday, July 6th to 10th, from Ten to Five o'clock.
Catalogues (2s. each) may be had, when ready, on application to the Auctioneers, Messrs.

Eadon & Lockwood, F.A.I., 2, St. James Street, Sheffield, or from the Auctioneers' Offices, at the Central Ordnance Depot, Chilwell, Notts.
Telephones: Central 111 and 1277 Sheffield.
Telegrams: "Weedon," Sheffield. U 489

FOR SALE.

40 Kw. Six Cyl. Parson Oil Driven GENERATING SET, 500 Volts, D.C., all accessories and Panels. All 3-34 Kw. 3 cyl. Sets. Details.—HARRY H. GARDAM & CO., LIMITED, Staines. U 617

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Gear-Cutting Apparatus. The Proprietors of British Letters Patent No. 18658, of 1914, are PREPARED to SELL the PATENT, or to license British Manufacturers to work under it. It relates to machinery for cutting curved or so-called spiral teeth, particularly on bevel gears.
Address:—B. W. & T.,
111-112, Hatton Garden,
London, E.C. 1. U 612

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Heating Stoves.—The Proprietor of British Letters Patent No. 120212 is PREPARED to SELL the PATENT, or to license British Manufacturers to work thereunder. It relates to domestic heating stoves for burning sawdust, in which air enters below a stepped grate at the bottom of an air-tight receptacle and the distillation gases pass downwardly through the fuel and burn under the grate.—Address, B.W. & T., 111 and 112, Hatton Garden, London, E.C. 1. U 613

The Proprietors of Letters Patent No. 133219, relating to "Means for Indicating the Corrections to be Applied for Deflection or Elevation when firing at Moving Targets," DESIRE to DISPOSE of their PATENT or to grant licences to interested parties on reasonable terms with a view to the adequate working of the patent in this country.
Inquiries to be addressed to
CRUIKSHANK & FAIRWEATHER,
65-66, Chancery Lane, London, W.C. 2. U 585

Vertical Boilers usually in STOCK or in Progress—from 4 ft. by 2 ft. to 11 ft. by 4 ft., with Cross tubes.—THE GRANTHAM BOILER & CRANE CO., Ltd., Grantham. 9991

40-48 HP. Stockport Gas ENGINE, complete with suction plant, perfect; £100. Two DYNAMOS, 110 volts, 100 amps., all switchgear, as new, £70.—WATSON, 12, Euclid Street, Swindon. U 557

Pumps.—Two Three-throw 9½ Rams Lee Howl manufacture, complete with 230 volt motors and electrical equipment.—INSULAR TRADING CO., LTD., Douglas, I.O.M. U 408

66 B.HP. Horizontal Hornsby OIL ENGINE, Belt Pulley 5 in. diam. by 1 ft. 9 in., 210 revs. Two Fly Wheels. Complete with Water Tanks and Compressed Air Starter, Oil Tank and Pump. In practically new condition.—Apply, EDMISTON, BROWN & CO., LTD., 219, St. Vincent Street, Glasgow. U 610

Locomotive, 2 ft. Gauge, Baldwin side tank 4-6-0. Excellent condition. Price £380. Great bargain.—E. W. FARROW AND SONS, Spalding. U 609

450 to 850 B.HP. 6-Cylinder DIESEL ENGINES, direct coupled 220-300 volts D.C. Generating Sets, also Electric Fan, Pumps, Compressors.—CLINKHAM WORKS, Halling, Kent. 831

May We Quote You for:—Jigs, Fixtures, Gauges, Special Cutting Tools, Gear Cutting, Grinding, Stampings, Pressings, Welding, Brazing, Tube, Sheet Metal or Coppersmith's work. Any Repetition Work, Machine or otherwise.
OUR MACHINE SHOP PLANT COVERS:—
Automatics to take all sizes up to 2½ in. diameter.
Capstans ditto 2 in. ditto.
Lathes ditto 14 in. diameter between centres.
Face Plate Work ditto 40 in. diameter 10 in. wide.
Universal Milling (up to 36 in. by 12 in. by 19 in.).
We ensure prompt delivery. First-class workmanship. Keen prices. U 589
TROJAN, LIMITED, Vicarage Road, Croydon.

For Sale at Attractive price:—
MILD STEEL BALING WIRE,
new, stock rusty only, in straight lengths, about 5 ft. 6 in. each, 11 and 12 gauge, in tight handy bundles.
Apply— U 568
THOS. W. WARD, LTD.,
Albion Works,
Sheffield.

4-WHEEL COUPLED SADDLE TANK LOCOMOTIVE (Hawthorn Leslie's), with outside cyls. 14 in. dia. by 20 in. stroke; 4 ft. 8½ in. gauge; 140 lbs. W.P.
10-TON TOWER-TYPE STEAM NAVVY (Ruston Proctor), with bucket, 1½ cubic yds. cap.; gauges 4 ft. 8½ in. and 11 ft.; boiler for 100 lbs. W.P.
"PRIESTMAN" DOUBLE-CHAIN GRAB, 4 ft. 2 in. wide, 5 ft. 2 in. long, 2 ft. deep, fitted with Automatic Opening Drum.
"PRICE'S" SINGLE-CHAIN GRAB, about 1½ cubic yards capacity, plate tine with short teeth.
3-TON "GRAFTON" LOCO. STEAM CRANE, with 31 ft. steel latticed derricking jib; 4 ft. 8½ in. gauge; boiler for 80 lbs. W.P.
CIRCULAR CENTRE-TIPPING SKIPS, from ¾ to 1½ cubic yards capacity each, large selection.
4-WHEEL COUPLED SADDLE TANK LOCOMOTIVE (Manning Wardle's), with inside cyls. 12 in. dia. by 18 in. stroke; 4 ft. 8½ in. gauge; 140 lbs. W.P.
CATALOGUE of Stock MACHINERY, 5-6000 Lots, Free on Application. Inspection Invited.
Thos. W. Ward, Ltd., ALBION WORKS, SHEFFIELD. 9778

G. R.
BY DIRECTION OF THE DISPOSAL BOARD.
SOUTHAMPTON.
The Valuable
Freehold Rolling Mills
Known as
GOVERNMENT ROLLING MILLS,
SOUTHAMPTON,
Including certain Plant,
TO BE SOLD
(By Private Treaty).
SITUATION.—The Property is situate in Weston Grove, close to the Railway, Tram and Ferry, and adjacent to the River Itchen, in which is situate a Jetty connected with the Factory.
AREA OF LAND.—About 62 acres.
BUILDINGS.—The main buildings are of substantial brick construction with Belfast truss roofs, and the property is equipped with the most modern Mills and auxiliary Plant and Machinery.
The principal buildings comprise:—

	Approx. floor area. ft. super.
Rolling Mills	124,200
Capping Shop	74,800
Foundry	74,800
Warehouse No. 1	19,900
Warehouse No. 2	11,400
Warehouse No. 3	12,200
Warehouse No. 4	19,900
TOTAL FLOOR AREA OF MILL ABOUT	337,200 FT. SUPER.

SIDINGS.—Private Sidings are laid and arrangements might be made with the Railway Company for a connection.
POWER AND LIGHTING.—Electric, generated by Plant on Site.
HEATING.—High and Low Pressure Steam and Hot Air Systems.
WATER.—From Public Main and Stream.
Further Particulars, Plan and Permits to View may be obtained on application to the CHIEF VALUER, Lands and Factories Section, Disposal Board-Room, 379, Caxton House, Tothill Street, Westminster, S.W. 1. U 580

For Sale, Four nearly New Taylor & Challen GUARD PRESSES, 18 in. stroke, 45 in. between standards, 14 in. hole in bed, pressure exerted 1000 tons.—Apply, GEORGE COHEN SONS & CO., 600, Commercial Road, London, E. 14. U 491

For Sale, High-Class GENERATING PLANT, comprising 140 Kw. Bellias-Lancashire Dynamo Combined Set, 440 volts D.C. Three similar Sets 75 Kw. each. Engines equal cylinders, suitable 80 lbs. pressure. Modern and in practically new condition, for delivery at once.—Address, U 297, Offices of ENGINEERING.

700 H.P. Horizontal Condensing ENGINE, by Hick, Hargreaves, Bolton, with Cylinder 32 in. diameter by 48 in. stroke, Rope Flywheel, modern and equal to new in every respect; also 550 H.P. Coupled COMPOUND CONDENSING ENGINE, by Marshalls, Gainsborough; both seen our Works and available for immediate delivery.—HARRY H. GARDAM & CO., LIMITED, Staines. U 83

Freehold Engineering Works FOR SALE AS A GOING CONCERN, belonging to the Torbinia Engineering Co., Ltd., at Oulton Broad, Lowestoft. The works are equipped with high-class Machine Tools and have a riverside frontage.
The Company makes the Nat Torbinia Semi-Diesel Type Oil Engine, both Marine and Stationary. 235 of such Engines are at present in use. U 592
For full particulars apply to BULLIMORE & CO., Chartered Accountants, Queen Street, Norwich.

Engineering Works for Sale. —TWO-STOREY BUILDING, situate at Newton Heath, Manchester. Area about 900 sq. yds., 999 years' lease (900 years to run). Plant in excellent condition, much of it quite modern. Would consider letting same, £500 deposit being required.—For further particulars write BOX 4169, T. B. BROWNE'S Advertising Offices, 71, Market Street, Manchester. U 615

Shipbuilding and Repairing YARD TO BE SOLD on South Coast for Yachts and Motor Coasters. Owner retiring. Special opening for trade on French coast and rivers. Capital required £20,000.—Address, U 569, Offices of ENGINEERING.

For Sale.—Two Galloway BOILERS, one 24 ft. long by 6 ft. 6 in. dia., passed for 150 lbs. working pressure, price £200 f.o.r.
The other 24 ft. long by 7 ft. 6 in. dia., passed for a 200 lbs. working pressure, price £250 f.o.r.
A number of fittings, including water level alarm, valves, etc., go with each Boiler.
Full particulars and copies of Insurance Reports will be sent on application to CADBURY BROS., LTD., Engineers' Office, Bournville. U 540

For Sale, Two Horizontal THREE-THROW HYDRAULIC PUMPS.
Capacity 52½ galls. per minute.
2240 lbs. pressure.
With or without 150 HP. Motors and Control Gear.
THE PHŒNIX ELECTRICAL CO., LTD.,
17, Oswald Street,
Glasgow. 822

For Sale, at a Reasonable Price, COMPLETE COAL GAS PLANT, to manufacture 350,000 cubic feet per 24 hours, including four Gasholders of respective capacities of 100,000, 94,000, 50,000 and 46,000 cubic feet. COMPLETE WATER GAS PLANT, to generate 500,000 cubic feet per 24 hours, with relief holder, boilers, etc. Both Plants are in first-class working condition, and suitable for re-erection.—For list apply to Mr. W. J. GIBBY, Secretary, Alliance and Dublin Consumers' Gas Co., D'Olier Street, Dublin. U 515

Messrs. Topham, Jones AND RAILTON, LIMITED,
CRYMLYN BURROWS,
SWANSEA.
HAVE FOR SALE:—Locomotives, Steam Navvies, Steam Goliath Cranes up to 40 tons capacity, Pile Drivers, Stone Breakers, Concrete Mixers, Boilers, Winding and Horizontal Engines, Steam Winches, Steam and Electric Pumps, Grabs, Electrical Plant, and a large assortment of Engineers' and Contractors' materials.
"CALL AND INSPECT." U 516

VICKERS LIMITED, BRITH.
Generating Plant for Sale. Four Bellis Compound H.S. Engines, 225 B.HP. at 160 lbs. boiler pressure, 360 r.p.m., coupled direct to four British Thomson-Houston Multipolar 150 Kw., 210 volts, D.C. Generators.
Two Wheeler Surface Condensers with steam-driven air and circulating pumps.
One Fraser & Chalmers Turbine, constructed for running on live or exhaust steam, or as a mixed pressure turbine. Coupled direct to two 240 Kw. Vickers 210 volts, D.C. Generators.
One Le Blanc Multiple Jet Condenser with combined rotary air and water pumps, and variable motor and switch.
Seven-Panel Switchboard for the above sets, complete with ammeters, wattmeters, speed indicator, rheostats, etc.
Steam and Condenser Mains, approx. 200 ft. run, with atmospheric valves, separators, traps, etc., as well as various spare armatures, pistons, etc.
The above plant is in good condition and the whole comprises a complete and economical generating set capable of an output of approx. 1100 Kw.
Available for immediate delivery.
Offers for the whole plant or separate portions are invited, and inspection can be made on written application to Messrs. VICKERS LIMITED, Brith.
A number of secondhand Water Tube, Lancashire and Semi-Marine Boilers, Feed Pumps, etc., are also for sale.
Particulars on request. U 451

PURE WATER for all purposes.
Particulars from 4261
The BUHRING'S Patent WATER PURIFYING Co., 146a, Queen Victoria Street, E.C. 4.

INDEX TO ADVERTISEMENTS.

	PAGE
Abbott & Co. (Newark) Ltd.	74
Acheson, E. G., Ltd.	86
Autograph Co., Ltd.	99
Atlas Shipbuilding Co., Ltd.	100
Alexander, R. P., & Sons	3
Alexander, Herbert, & Co.	100
Allen-Liversidge, Ltd.	68
Allen, W. H., Sons & Co. Ltd.	83
Anderson, D., & Son, Ltd.	94
Andrews & Beaumont	1
Angus, Geo., & Co., Ltd.	20
Armstrong, Stevens & Son	70
Arrol, Sir W., & Co., Ltd.	93
Ashworth, John, & Co.	99
Asquith, Wm. (1920), Ltd.	45
Assoc. British Machine Tool Makers, Ltd.	45
Aster Engineering Co., Ltd.	83
August's Muffle Furnaces	100
Auld, David, & Sons, Ltd.	97
Avaling & Porter, Ltd.	1
Bagnall, W. G., Ltd.	82 & 100
Balderston & Co., Ltd.	11
Barker, Spink, Lease & Co.	78
Bassett-Lowke, Ltd.	100
Beardmore, Wm., & Co., Ltd.	57
Bedford Engineering Co.	9
Beebee, A.	100
Beldam Pkg. & Rubber Co.	22
Bell, G. & Sons, Ltd.	3
Bellamy, John, Ltd.	1
Bellies & Morcom, Ltd.	74 & 99
Bennis, Ed., & Co., Ltd.	92
Bergius Launch & Engine Co., Ltd.	94
Berry, Francis, & Sons	89
Berry, Henry, & Co., Ltd.	92
Bertrams, Ltd.	100
Billington & Newton, Ltd.	52
Birch, John, & Co., Ltd.	82
Birm. R. C. & W. Co., Ltd.	74
Blundell's London Copper & Brass Works, Ltd.	99
Bodley Bros. & Co., Ltd.	11
Booth, Jos., & Bros., Ltd.	92
Boving & Co., Ltd.	11
Boving Engineering Works Ltd.	98
Braby, Fred., & Co., Ltd.	9
Bradley & Craven, Ltd.	84
Braime, T. F., & Co., Ltd.	78
Brett's Patent Lifter Co. Ltd.	80
British Nicluase Boiler Co.	100
British Ropeway Eng. Co.	82
British Steam Specialties	75
British Thomson-Houston Co., Ltd.	80
Broadbent, T., & Sons, Ltd.	98
Broom & Wade, Ltd.	84
Brotherhood, Peter, Ltd.	83
Broughton Copper Co., Ltd.	98
Brown, David, & Sons (Huddersfield), Ltd.	27
Brown, W. R., & Co. (Bankhall), Ltd.	99
Brundrit, Joseph	99
Brush Elec. Eng. Co., Ltd.	67
Buck & Hickman, Ltd.	62
Budenberg Gauge Co., Ltd.	22
Buhring's Patent Water Purifying Co.	4
Bullivant & Co., Ltd.	85
Bull's Metal & Melloid Co.	99
Butcher, Henry, & Co.	1
Butler, Samuel, & Co., Ltd.	98
Butterfield, W. F., Ltd.	13
Butterley Co., Ltd.	80
Butterworth Bros., Ltd.	8
Buyers of Scrap Metal, Ltd.	82
Caird & Rayner	101
Cammell, Laird & Co., Ltd.	69
Campbell & Calderwood Ltd.	20
Campbell Gas Engine Co.	96
Campbells & Hunter, Ltd.	1
Carels, Diesel & Steam Engines (London), Ltd.	18
Cawood, G. R., & Co.	101
Cerotti & Tanfani	15
Chalmers, Wm., & Co., Ltd.	19
Chambers, Scott & Co., Ltd.	93
Chaplin, Alex., & Co., Ltd.	25
Charpillos, Daniell Freres and Co., Ltd.	96
Chesterfield Tube Co., Ltd.	16
Christiani & Nielsen	20
Citroen Gear Co., Ltd.	11
Clarke, Chapman & Co., Ltd.	65
Clayton, Son & Co., Ltd.	21
Cleveland Bridge & Eng. Co.	101
Clyde Structural Iron Co.	74
Cochran & Co. (A.), Ltd.	1 & 17
Cockburn, A., & Co.	76
Cockburn & Ltd.	15
Coles, Henry J., Ltd.	21
Consolidated Brake & Eng. Co. Ltd.	101
Constructional Engineering Co., Ltd.	100
Cooke, James, & Son	8
Cowans, Sheldon & Co., Ltd.	26
Cradley Boiler Co., Ltd.	81
Crockatt, W., & Sons, Ltd.	10
Crofts (Engineers), Ltd.	5
Cromite Foundry Co., Ltd.	77
Crosby Valve & Eng. Co.,	96
Crowley Bros., Ltd.	71
Dalgliah, A. & W.	76
Dallow Lambert & Co., Ltd.	79
Daniell, S. A., Ltd.	93
Daniels, T. H. & J., Ltd.	74
Danks, H. & T. (Netherton)	8
Darlington Forge, Ltd. (The)	99
Davidson & Co., Ltd.	64
Davis, E. J.	3
Davis & Primerose, Ltd.	78
Davy Brothers, Ltd.	47
Dawson & Downie, Ld.	8
Day, Summers & Co., Ltd.	20
Delta Metal Co., Ltd.	1
Dempster, Moore & Co., Ld.	77
Dempster, Robt., & Sons, Ltd.	8
Dennystown Forge Co.	7
Dorman, W. H., & Co., Ltd.	44
Drum Engineering Co., Ld.	75
Drummond Bros., Ltd.	17
Drysdale & Co., Ltd.	69
Dublin Dockyard Co., Ltd.	93
East Ferry Road Engineering Works Co., Ltd.	18
Edmeston, A., & Sons, Ltd.	14
Electro-Metals, Ltd.	18
Elliott, Geo., & Co., Ltd.	7
Ellison, W. T., & Co., Ltd.	101
English Electric Co., Ltd.	55
Entwisle & Gass, Ltd.	74
Escher, Wyss & Co.	83
Evans, Joseph, & Sons, Ltd.	88
Fawcett, Preston & Co., Ltd.	75
Ferguson Bros. (Port Glasgow) Ltd.	93
Firth, Thos., & Sons, Ld.	39
Fisher, Humphries & Co., Ld.	82
Fleming & Ferguson, Ltd.	7
Fletcher, George, & Co., Ltd.	97
Foster Bros., Ltd.	83
Foster Instrument Co.	52
Fowler, John, & Co. (Leeds)	81
Fuller, Horsey, Sons & Cassell	1
Gartsherrie Eng. & Forge Co.	1
Gibbons Bros., Ltd.	66
Gilkes, G., & Co., Ltd.	81
Gillman, Frank	74
Glasgow Rly. Eng. Co., Ltd.	1
Glenfield & Kennedy, Ltd.	66
Globe Pneumatic Eng. Co.	27
Goodacre, Wm. & Sons, Ltd.	94
Goodwin, Barsby & Co.	74
Grafton & Co.	101
Grantham Boiler & Crank Co.	4
Green, E. & Son, Ltd.	102
Grieve, John, & Co.	100
Grover & Co., Ltd.	76
Guest & Chrimes, Ltd.	78
Gunther, W., & Sons	100
Halden, J., & Co., Ltd.	18
Hale, Thos. L., Ltd.	28
Halesowen Steel Co., Ltd.	80
Hall, B. J., & Co., Ltd.	95
Hall, J. & E., Ltd.	11
Hall, J. P., & Sons, Ltd.	92
Hall, J. P., & Co., Ltd.	17
Hampton & Beebee, Ltd.	19
Hanworthy Eng. Co., Ltd.	99
Hands, John, & Sons, Ltd.	14
Hardy & Padmore, Ltd.	60
Harris Patent Feed Water Ltd. (1910), Ltd.	76
Hart, Thos., Ltd.	100
Hartnell, Wilson & Co., Ltd.	74
Harvey, G. & A., Ltd.	13
Haslam Foundry & Eng. Co., Ltd.	98
Hawthorn, R. & W., Leslie & Co., Ltd.	1 & 87
Head, Wrightson & Co., Ltd.	1 & 65
Henderson & Glass	75
Henderson, J. M., & Co.	94
Hendry, James, Ltd.	94
Herbert, Alfred, Ltd.	96
Heywood, S. H., & Co., Ltd.	1
Hick, Hargreaves & Co., Ltd.	31
Higginbottom & Mannock	78
Hoffmann Mfg. Co., Ltd.	31
Hollingdrake, Henry & Sons	101
Hollings & Guest, Ltd.	9
Hooper & Weyman	100
Hopper, Henry, & Sons	6
Hopkinson, J., & Co., Ltd.	14
Horne Engineering Co.	101
Howell & Co., Ltd.	98
Hudson, Thos., Ltd.	68
Hud-well, Clarke & Co., Ld.	86
Hughes & Lancaster, Ltd.	101
Humphreys & Glasgow, Ltd.	53
Hunslet Engine Co., Ltd.	97
Hunt, Thomas, & Sons	3
Hurst, Nelson & Co., Ld.	1
Hyatt, Ltd.	40
Hydraulic Gears, Ltd.	59
Igranic Electric Co., Ltd.	73
International Electrolytic Plant Co., Ltd.	73
Ironite Co., Ltd.	12
Isler, C., & Co., Ltd.	61
Jack, Alex., & Co., Ltd.	23
Jackson, F. R., & Co., Ltd.	22
Jardine, John, Ltd.	101
Jenkins Bros, Ltd.	14
Jenkins, W. J., & Co. Ltd.	92
Jennings, E. J.	1
Johnson, W., & Sons (Leeds), Ltd.	94
Jones & Lamson Mach. Co.	98
Jones, A. A., & Shipman, Ld.	77
Keay, E. C. & J., Ltd	76
Keighley Gas & Oil Engine Co., Ltd.	76
Kenyon, A., & Co., Ltd.	100
Kermodes, Ltd.	1
Kirkaldy, John, Ltd.	1
Kirk, Wheatley, Price & Co.	84
Kirkstall Forge Ltd.	102
Klinger Patents	36
Knowles, G. P.	2
Kynoch, Ltd.	21
Lancaster & Tonge, Ltd.	100
Lang, John, & Sons	45
Lea Recorder Co., Ltd.	96
Leathers Co. (Alt.), Ltd.	25
Leeds Eng. & Hyd. Co., Ltd.	92
Lees, T. & R.	11
Lidgerwood Mfg. Co.	58
Lindsay, R. B., & Co.	6
Llewellans Machine Co.	22
Lockwood & Carlisle, Ltd.	90
Lodge Plugs, Ltd.	100
London Electric Firm	74
London Brass, Ltd.	101
Lunken Co., Ltd.	15
Lysaght, John, Ltd.	29
McGowan, Wild & Co.	101
McKie & Baxter	90
MacFarlane Eng. Co. Ltd.	100
Maclellan, P. & W., Ltd.	1
Magnolia A.-F. Metal Co. of Great Britain, Ltd.	83
Maiden & Co., Ltd.	64
Manchester Steam Users Association	2
Manning, Wardle & Co., Ltd.	1
Marine Loco. Superheaters Ltd.	81
Marshall, Fleming & Co. Ltd.	12
Massey, B. & S., Ltd.	90
Mavor & Coulson, Ltd.	100
Maxted & Knott, Ltd.	1
Maxwell & Farr	100
Meldrums, Ltd.	93
Michell Bearings, Ltd.	100
Mild Steel Castings, Ltd.	79
Mirrlees Watson Co., Ltd.	33
Mitchell Conveyor and Transporter Co., Ltd.	101
Motherwell Bridge Co., Ltd.	28
Mountford, Fredk.	79
Muir, Wm., & Co., Ltd.	79
Mumford, A. G., Ltd.	1, 25 & 29
Munts, P. H., & Co., Ltd.	84
Murray, McVinnie & Co. Ltd.	78
Musgrave Bros.	98
Musgrave & Co., Ltd.	17
Napier Bros., Ltd.	85
National Boiler & General Insurance Co., Ltd.	85
Newton, Chambers & Co. Ltd.	89
Noble & Lund, Ltd.	89
North British Loco. Co. Ltd.	86
North Eastern Marine and Engg. Co., Ltd.	83
North Eastern Railway Co.	10
Northern Engineering Wks.	9
Notcutt, W. F., Ltd.	15
Oak Foundry Ltd.	92
Oakey, J., & Sons, Ltd.	89
Osborn, S., & Co., Ltd.	27
Owen & Crisp	1
Parker Foundry Co., Ltd.	83
Parkinson, J., & Son	45
Partington Steel & Iron Co., Ltd.	71
Pat Lightning Crusher Co.	6
Paterson Eng. Co., Ltd.	10
Paul, Matthew & Co., Ltd	1
Pearn, Frank, & Co. Ltd.	26
Peckett & Sons, Ltd.	97
Pegler Bros. & Co. (Glas.) Ltd.	76
Petters, Ltd.	1
Phillips, Trevor W.	2
Pickering, R. Y., & Co., Ltd.	1
Piggott, Thos., & Co., Ltd.	1
Platt, Samuel, Ltd.	85
Player, W. & J.	9
Pott, Cassels & Williamson	1
PowerGas Corporation, Ltd.	13
Power Plant Co., Ltd.	46
Prestwitt Bros.	100
Priestman Bros. Ltd.	90
Princeps & Co.	93
Proctor, Jas., Ltd.	16
Pulsometer Eng. Co., Ltd.	102
Ransome, A., & Co., Ltd.	93
Ransome & Marles Bearing Co. Ltd.	99
Rapid Magnetting Mch. Co.	100
Ross Roturbo Mfg. Co., Ltd.	16
Reid Gear Co.	79
Relay Automatic Telephone Co., Ltd.	96
Reyrolle, A., & Co., Ltd.	93
Richardsons, Westgarth and Co., Ltd.	99
Ritchie-Atlas Engineering Co.	98
Robinson, Thos., & Son, Ld.	89
Rose & Duncan	9
Rosser & Russell, Ltd.	3
Rownson Drew & Clydesdale, Ltd.	76
Royce, Ltd.	11
Roylos Ltd.	1
Russell, G., & Co., Ltd.	1 & 102
Russell, John, & Co., Ltd.	13
Ruston & Hornsby, Ld.	36 & 35
Salterns Ltd.	22
Scott, Greenwood & Son	3
Scottish Stamping & Engg. Co. Ltd.	23
Scottish Tube Co., Ltd.	1
Seagers Ltd.	18
Shanks Thomas, & Co.	45
Shaw, W., & Co.	21
Shepard Electric Crane and Hoist Co.	19
Shore Instrument & Mfg. Co., Ltd.	79
Shore, Thos., & Sons, Ltd.	11
Sisley, Gorman, & Co., Ltd.	99
Simon-Carves, Ltd.	18
Skinner Chuck Co.	86
Smethwick Stamping Co. Ltd.	84
Smidth, F. L., & Co., Ltd.	6
Smith, F. J., & Co., Ltd.	1
Smith, Hugh, & Co., Ltd.	7
Smith, T., & Sons (Rodley), Ltd.	100
Société de Produits Metallurgiques	3
Sokal, S.	3
Somers, Walter, Ltd.	1
Spencer-Bonecourt, Ltd.	1 & 80
Spencer, John, Ltd.	92
Standard & Oswald Stott (Engineers) Ltd.	86
Standard Piston Ring and Eng. Co., Ltd.	94
Steam Fittings Co., Ld.	74
Steel Co. of Scotland, Ltd.	12
Steel Construction Co., Ltd.	66
Steel Pipe Co., Ltd.	74
Stephenson, Robert, & Co.	99
Sterne, L., & Co., Ltd.	21
Steven, A. & P.	77
Steven & Struthers	99
Stewart, Duncan, & Co., Ltd.	73
Stewarts & Lloyds, Ltd.	1 & 102
Still Engine Co., Ltd.	94
Stone, J. B., & Co., Ltd.	77
Stone, J., & Co., Ltd.	92
Stothert & Pitt, Ltd.	37 & 41
Sturtevant Eng. Co., Ltd.	97 & 99
Submersible Motors, Ltd.	77
Sudron, Thos., & Co., Ltd.	89
Summerson, T., & Sons, Ltd.	1 & 75
Superheater Corporation Ld.	19
Sutcliffe Bros. & Heyes, Ltd.	69
Tattersall, A. A., & Co.	3
Taylor & Challen, Ltd.	1
Telephone Manufg Co., Ltd.	72
Thomas & Bishop, Ltd.	89
Thompson Bros. (Bilston), Ltd.	90
Thompson, John, (Wampu) Ltd.	21 & 88
Thurston, A. P.	1
Thwaites Bros., Ltd.	85
Todd Shipyards Corpn.	1
Tomey, J., & Sons, Ltd.	100
Trice Bros., Ltd.	103
Tubes, Ltd.	62
Tullis, D. & J., Ltd.	97
Turbine Furnace Co.	108
Turbine Gears, Ltd.	33
Turnbull, A. A., & Co., Ltd.	74
Underfeed Stoker Co., Ld.	63
Valor Co., Ltd.	78
Variable Speed Gear, Ltd.	67
Vibration speciality Co.	89
Vickers Limited	45 & 46
Vickers-Petter, Ltd.	1
Vosper & Co., Ltd.	1
Wadkin & Co.	79
Walker, James, & Co., Ltd.	94
Wallwork, Henry & Co., Ltd.	11
Ward, Thos. W., Ltd.	4
Webb & Son (Combs), Ltd.	100
Webster & Bennett, Ltd.	98
Weir, G. & J., Ltd.	47
Wells, A. C., & Co.	25
Werf Conrad	1
West, H. J., & Co., Ltd.	100
Westinghouse Brake and Saxby Signal Co., Ltd.	61
Wharton, H., Ltd.	60
Wheler Manfg. Co., Ltd.	74
White, Jacoby & Co., Ltd.	11
White, J., Samuel & Co., Ld.	91
White, Ed., & Sons	74
Wigglesworth, F., & Co. Ld.	86
Wiley, James & Sons, Ltd.	79
Wilkins & Mitchell	101
Willcox, W. H. & Co., Ltd.	3
Wills, W. & F., Ltd.	3
Wilson, J. H., & Co., Ltd.	94
Wilson, William, & Co.	100
Winoott, G. F., Ltd.	28
Wood, Henry, & Co., Ltd.	79
Wood, Hugh, & Co. Ltd.	98
Woodite Company	77
Worthington-Simpson, Ld.	49
Wright's Forge & Eng. Co.	78
Yarrow & Co., Ltd.	1
Yorkshire Engine Co., Ltd.	87

"PENBERTHY" PATENT

INJECTORS

AUTOMATIC RESTARTING, also AUTO-POSITIVE.

For low, medium and high pressure boiler feeding. Reliable and efficient.

LARGE STOCKS. All Sizes.

BRASS REGRINDING, GLOBE, GATE, and "COMPODISK"

VALVES

Superior in design, material and workmanship.

"WILLCOX" HAND SEWN

LEATHER BELTING

Made from centres of fully-stretched prime selected ox hides, in our own factory.

Also Hair, Cotton, Balata, &c., BELTINGS.

Also Willcox "Balatite" (reg. trade mark) Belting.

Willcox's

9550

ENGINEERS' STORES

including Lubricating Oils and Greases, Semi-Rotary Pumps, Wirebound (non-rubber) Hose, Cellar &c. Drainers, Packings and Jointings, Tools, &c.

LET US QUOTE FOR YOUR REQUIREMENTS.

W. H. WILLCOX & Co., Ltd., 32-38, Southwark Street, London, S.E. 1.

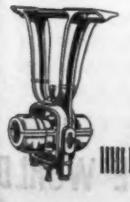
THE BEST CROFTS IN THE WORLD

•WE•DESIGN•LAYOUT•MANUFACTURE•and•ERECT•COMPLETE•

POWER TRANSMISSION

•INSTALLATIONS•

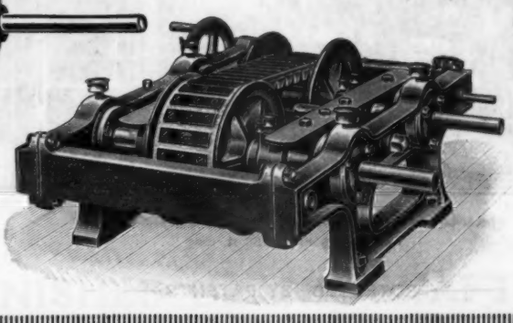
CROFTS GEARS may be attached to WALL, FLOOR or CEILING



We have supplied thousands for ALL classes of machinery.

Please let us quote for your requirements.

Catalogue on request.



You can obtain the EXACT speed required at once by installing CROFTS

VARIABLE SPEED GEAR

"The Most Efficient Made."

Buy from the Actual British Makers:

CROFTS LTD

ENGINEERS

4862

BRADFORD, ENG.

HOPES' LOK'D BAR SASH

STRONGEST, LIGHTEST & BEST.

THE PATENT LIGHTNING

CRUSHER & PULVERIZER

The Best on the Market for reducing hard materials such as Flint, Shingle, Gravel, Silica, Magnesite, Barytes, etc.; also Limestone, Chalk, etc.

TELEGRAMS:— "AGENCIADOR, LONDON." TELEPHONE:— 4656 CITY.

Invaluable for CONCRETE and BUILDING SAND.

7174

THE PATENT LIGHTNING CRUSHER CO., Ltd., 14a, Rosebery Avenue, LONDON, E.C.

F. L. SMIDTH & CO. LTD.

Consulting and Contracting Engineers,

TELEGRAMS: CHALKINESS ESTRAND LONDON. **20 ESSEX STREET LONDON W.C. 2.** TELEPHONE: CENTRAL 2126.

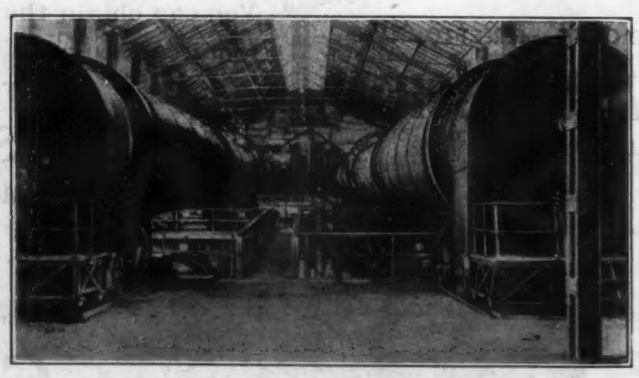
Associated with F. L. Smidth & Co., Copenhagen.

ENGINEERING WORKS AT LUTON, COPENHAGEN, NEW YORK.

CRUSHERS AND GRINDING MILLS FOR ORE.

Lowest Power Consumption per ton of ground material. Maximum Output. Most Reliable Working.

ROTARY KILNS
DRYERS
ELEVATORS
SHAKING CONVEYORS
EXCAVATORS
EXILOR PACKERS
BRICK-MAKING MACHINES



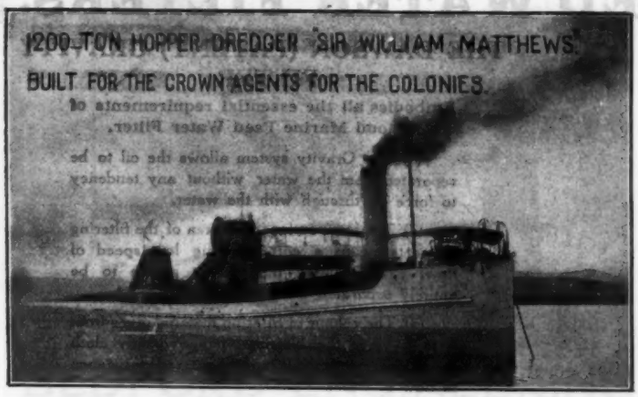
Interior of the Kiln House in a Portland Cement Works.
Two Rotary Kilns 250 ft. long.

CRUSHERS
ROLLER MILLS
KOMINORS
TUBE MILLS
STEEL BALLS
CYLPEBS
FLINT PEBBLES

PROTECTED BY PATENTS

641

WE HAVE NEARLY 5000 OF OUR GRINDING PLANTS WORKING IN ALL PARTS OF THE WORLD



DREDGING PLANT.

TO THE LARGEST DIMENSIONS AND CAPABILITIES.

PATENT CUTTER HOPPER DREDGERS

To discharge into their own hoppers, into barges alongside, or ashore through floating pipes.

FLOATING CRANES.

ROCK BREAKING PLANT (UNDERWATER).

Hopper Barges, Screw Steamers, Side and Stern Paddle Wheel Steamers, Tug Steamers, &c.

New Buckets, Links, Pins, Gearing, &c., supplied for existing Dredgers.

FLEMING & FERGUSON, LTD.,

SHIPBUILDERS AND ENGINEERS, PAISLEY, N.B. Od.1283

London Office: 91, VICTORIA ST., WESTMINSTER, S.W. 1. Established 1878.

GEORGE ELLIOT & CO., LTD.

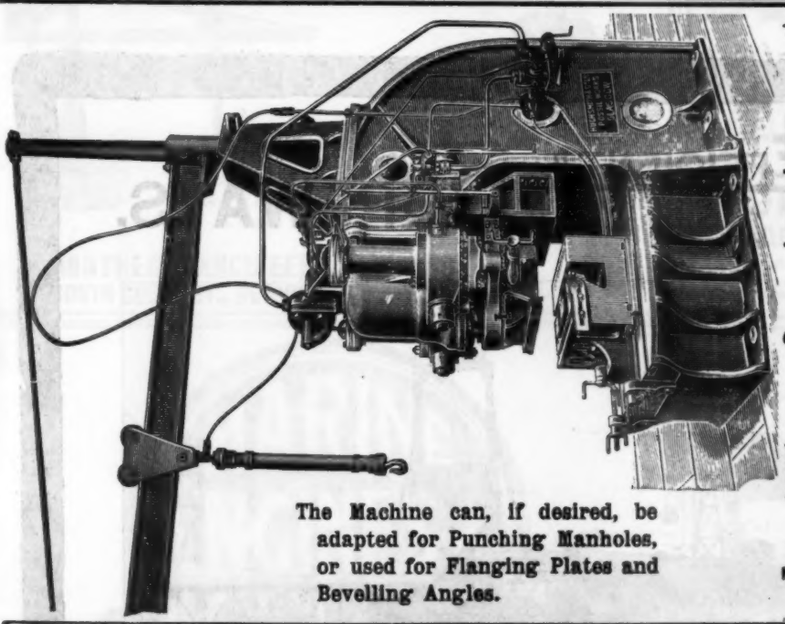
MANUFACTURERS OF PATENT

LOCKED WIRE ROPES AND LANG'S LAY WIRE ROPES,

And other Wire Ropes for Mines, Cranes, Lightning Conductors, Hawsers, &c.

OFFICE: 16, GREAT GEORGE STREET, WESTMINSTER, LONDON.

LOCKED COIL ROPE Od.9100



This Illustration shows

LAMBIE'S PATENT COMBINED HYDRAULIC SHIP-FRAME AND PLATE JOGGLING MACHINE,

For Joggling Angle, Bulb Angle, or Channel Bars, as used in Ships' Frames, or for Joggling Ships' Plates to obviate the use of packing slips.

The Machine can, if desired, be adapted for Punching Manholes, or used for Flanging Plates and Bevelling Angles.

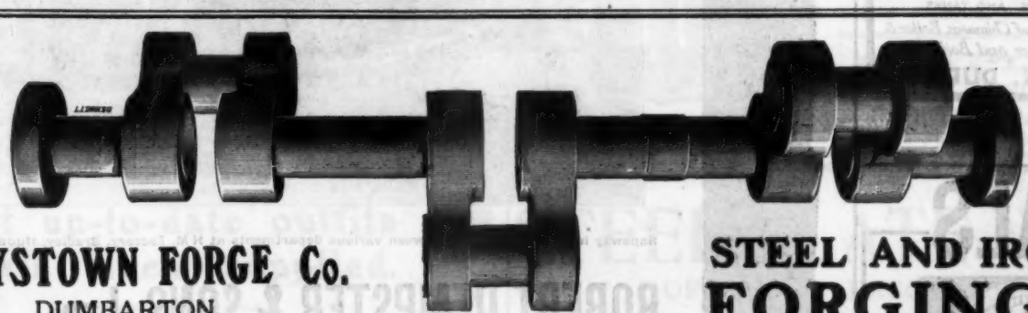
SOLE MAKERS:

HUGH SMITH & Co., Ld.

Possil Works, GLASGOW.

ALSO MAKERS OF 8000

Machine Tools for Shipbuilders and Boilermakers, such as Bending, Flanging, Riveting Machines, &c.



DENNYSTOWN FORGE Co.

DUMBARTON.

TELEGRAMS: FORGE, DUMBARTON. TELEPHONE: No. 56.

ON ADMIRALTY, WAR OFFICE and CROWN AGENTS LISTS.

LONDON OFFICE: 39, VICTORIA ST., WESTMINSTER, S.W. 1.

NEWCASTLE OFFICE: PRUDENTIAL BUILDINGS.

BELFAST OFFICE: 101, BRIDGE END.

LIVERPOOL OFFICE: CHURCH HOUSE, LORD STREET.

STEEL AND IRON FORGINGS

UP TO ANY WEIGHT.

SPECIALITIES :— REPAIR WORK OF ALL DESCRIPTIONS, ALSO FINISHED HOLLOW CRANK AND LINE SHAFTING, FORGINGS FOR TURBINE ENGINES (WHEELS, SPINDLES, DRUMS, &c.).

PATENTEES OF THE "WEDGWOOD" PATENT VERTICAL INTER-LOCKING SCARPHED JOINTED RUDDER. 717

Exceptionally Quick Delivery GIVEN FOR **FINISHED CRANK SHAFTS, PROPELLER SHAFTS** with CONTINUOUS GUN-METAL LINERS COMPLETE, and **STERN AND RUDDER FRAMES.**

R.B. LINDSAY & Co.
38 MAIR ST PLANTATION GLASGOW
USED IN HUNDREDS OF STEAMERS OF PRINCIPAL LINES
FOR ALL STEAM PRESSURES
TEL. CONICAL GLASGOW
PATENT CONICAL
ENGINE PACKING

ENCOURAGE HOME INDUSTRIES.
We manufacture Dressers and Tel. 6273.
Abrasive Wheels Machines. Est. 1893.
CORUNDUM WHEELS
48·8 48·8
A.A. TATTERSALL & Co. MAKERS BLACKBURN

MARINE FEED WATER FILTERS.

DAWSON GRAVITY FEED WATER FILTER.
Correct in design and action. Moderate in price.

THE DAWSON (PATENT) GRAVITY FILTER.
Embodies all the essential requirements of a good Marine Feed Water Filter.

(1) The Gravity system allows the oil to be separated from the water without any tendency to force oil through with the water.

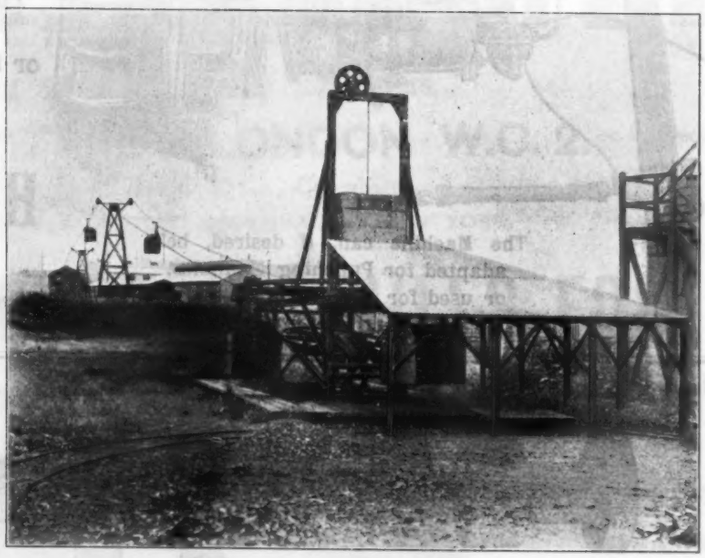
(2) The large surface and area of the filtering elements means a corresponding low speed of flow. This allows the oil or grease to be entirely separated from the water.

(3) The volume of filtering material gives from 4 to 6 times the filtering volume of any cloth covered filter without any increased resistance to flow of water.

DAWSON & DOWNIE, LTD.
ELGIN WORKS, 9699
TELEGRAMS: FUMPS CLYDEBANK.
CLYDEBANK.
TELEPHONE: 92 & 93 CLYDEBANK.

H. & T. DANKS (NETHERTON) Ltd
MAKERS OF LANCASHIRE & CORNISH BOILERS, STEEL CHIMNEYS AND TANKS.
Specialists in Building of Chimneys, Boiler & Economiser Settings and Boilerhouses.
NETHERTON, DUDLEY.
767

"EFFICIENT" ROPEWAYS.



Ropeway handling chemicals between various departments at H M. Factory, Bradley, Huddersfield

ROBERT DEMPSTER & SONS, LTD
ELLAND—YORKS.
9651

DIALS

STEAM GAUGE DIALS, 9841
INDICATING MACHINE DIALS &c.
JAMES COOKE & SON,
8 & 9, WRENTHAM ST., BIRMINGHAM.
Specialists in Dials. Est. 75 Years.
'Phone: MID. 1611. Grams: "Horology," Birmingham.

TELEGRAMS:
CRANES, BEDFORD.
TELEPHONE:
33 BEDFORD

9022

BEDFORD·ENGINEERING COMPANY

BEDFORD ENGLAND

NORTHERN CRANES AND HOISTS.

8918

Let us send you our Catalogues of Electric and Pneumatic Cranes and Hoists—free.

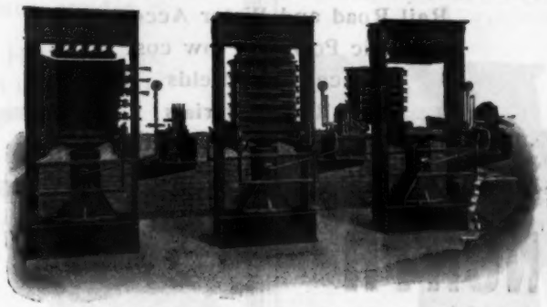
NORTHERN ENGINEERING WORKS,
SOUTH CHENE ST., DETROIT, MICH., U.S.A.

BALING OF GROUND NUTS AND OTHER SEEDS.

SPECIALLY DESIGNED HYDRAULIC PLANT FOR THIS PURPOSE.
GREAT SAVING IN FREIGHT AND TRANSPORT.

50°/. REDUCTION IN BULK!

NO INJURY TO KERNELS—LESS LIABLE TO DECOMPOSITION.



BATTERY OF 3 PRESSES RECENTLY SUPPLIED.

CAN BE WORKED BY HAND-POWER, HORSE, CAPSTAN, ENGINE, OR ELECTRIC MOTOR.

For Ease and Convenience of Packing and Handling.
LESS THAN HALF SPACE TAKEN BY LOOSE SEEDS.

Send for Full Particulars and Prices of this Money-Saving Method of Dealing with Nuts and Seeds.

HOLLINGS & GUEST, LTD.,
THIMBLE MILL LANE - - BIRMINGHAM.
Sole Agent for Scotland:—MR. D. LANDALE FREW, 45, HOPE ST., GLASGOW. 9730

MARINE ENGINES & BOILERS

FOR VESSELS CONSTRUCTED ABROAD

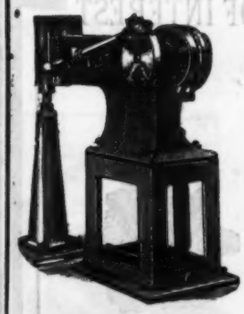
Most up-to-date outfits of all sizes supplied.

Over 1000 sets of Engines and 1500 Boilers already constructed and working in all parts of the world.

Admiralty Contractors. Telegrams: 656 WHITEFIELD, GLASGOW.

ROSS & DUNCAN.
WHITEFIELD WORKS, GLASGOW.
ESTABLISHED 1876.

PLAYER'S
Patent Pneumatic
POWER HAMMERS



PLANISHING HAMMER.
List PH/06.

For Forging, Planishing, Rivetting, Sheet Metal and Panel Beating, Swaging, Drawing Down, and for all Purposes.

SEE LISTS GF/06, AP/06, PH/06.

W. & J. PLAYER,
Smithfield Works, SHERLOCK STREET,
BIRMINGHAM. 9583
Telegrams—METHOD, B'HAM. Telephone—MIDLAND 1402

STEEL PLATE WORK
OF EVERY DESCRIPTION.

TANKS. CYLINDERS.
HOPPERS. SKIPS & BOGIES.
CHIMNEYS.
SILENCERS. BUNKERS.
TRUNKING. SPIRAL CHUTES.

F. BRABY & CO., Ltd.,
HAVELOCK WORKS,
LITHERLAND, LIVERPOOL. 9513

And at LONDON, DEPTFORD, BRISTOL, GLASGOW, FALKIRK, BELFAST & DUBLIN.

SITES for WORKS

with

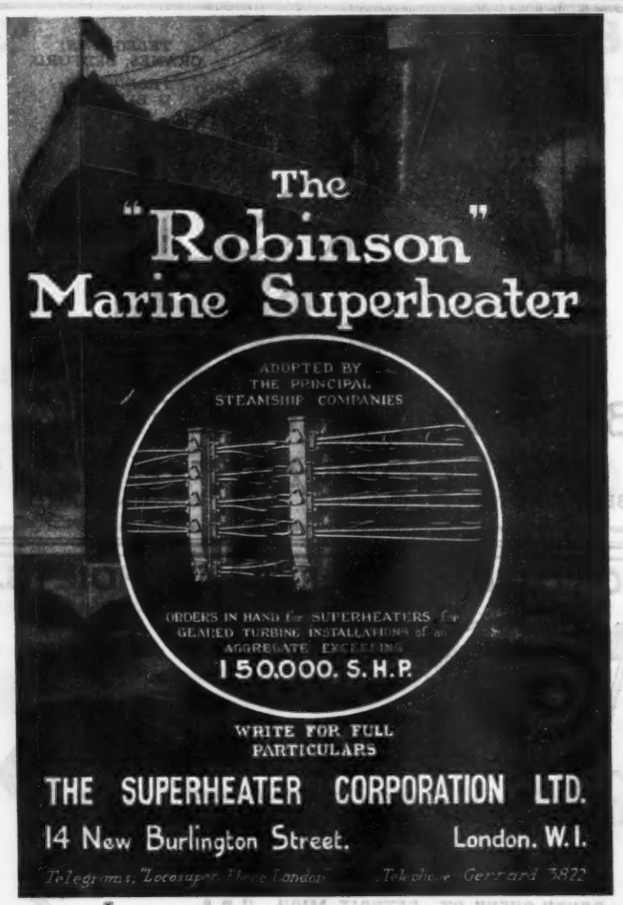
Rail Road and Water Access
Electric Power at low cost
Adjacent Coalfields
Local Raw Materials
Proximity to Large Ports

Can be obtained in

"NORTH EASTERN" ENGLAND

9997

Address enquiries to—THE COMMERCIAL AGENT,
NORTH EASTERN RAILWAY, YORK.



CROCKATT SIMPLEX

TWO SPECIALTIES OF INTEREST.

VALVE RESEATER
CURES LEAKING VALVES.

For Refacing the Seats of all kinds of Valve Chests, whether with flanged or screwed covers, without disturbing the Valve Chests.

Leaking Valves can easily be made tight with this machine. It can be used in very confined spaces.

To
Power Engineers.

FEED WATER
SUCTION FILTER
SIMPLE, EFFECTIVE, FILTERING MEDIUM EASILY CLEANED AND REPLACED.
PRICE EXTREMELY MODERATE.
Large numbers in successful operation.
Supplied with or without bypass.

Write for List "M" which gives full particulars.

W. CROCKATT & SONS, LTD

9876

64, Darnley Street, Glasgow,
and at 12, Bath Street, Liverpool.

PATERSON WATER SOFTENER.

BOILER FEED ECONOMY.

PURE WATER for boiler feed is essential for economical and efficient steam raising. It prevents all scaling and priming troubles, reduces coal consumption and prolongs the life of the boiler.

Paterson Water Softeners

Paterson Oil Eliminators

9877

PATERSON ENGINEERING CO., LTD.,
21, WINDSOR HOUSE, KINGSWAY, W.C. 2.

J. & E. HALL, LTD.,

Makers of CO_2 and NH_3

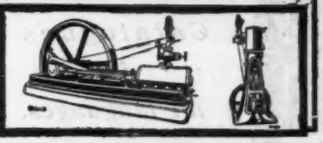
Refrigerating Machines

—and—

Hallford Motor Vehicles

10, ST. SWITHIN'S LANE, LONDON, E.C. 4.
31, Dale Street, Liverpool,
and DARTFORD, KENT. 565

T. & R. LEES, LTD
HOLLINWOOD.
STEAM ENGINES



Established 1835.
HOYT LEATHER BELTING
"FLINTSTONE" PURE OAK TANNED.

The Best is the Cheapest for all Drives.

"Turtle" 9584 Brand Guaranteed Waterproof.

BALDERSTON & CO., LTD.,
201, ST. VINCENT STREET, GLASGOW.

Wallwork
HIGH EFFICIENCY
WORM GEARS
9654 DELIVERY FROM STOCK.
HENRY WALLWORK & CO., LTD., MANCHESTER.

On Admiralty List.
BODLEY BROS & Co. Ld.
Engineers, Millwrights, Boiler Makers and Iron and Brass Founders.
OLD QUAY FOUNDRY, **EXETER.**

SPUR, BEVEL, MITRE, MORTICE AND
WORM WHEELS,
Machine Moulded
ALSO
TEETH CUT TO SHAPE
By Special Machinery

Telegraphic Address— 581
BODLEY, EXETER.
ESTABLISHED 1790.

Accuracy in Gear Cutting.

The first essential for Double Helical Gears is accurate cutting. When this is achieved, the advantages of silent running, strength, durability and efficiency will be realised. Without this accuracy, trouble is more likely to be the result.

When purchasing Double Helical Gears, it should be remembered that the makers of

Citroën Gears

set perfection as their standard.

The greatest possible care is bestowed on the manufacture of each individual set of Gears, and each set is tested before despatch.

Specify "Citroën Gears," not just "Double Helical Gears," for your next job.

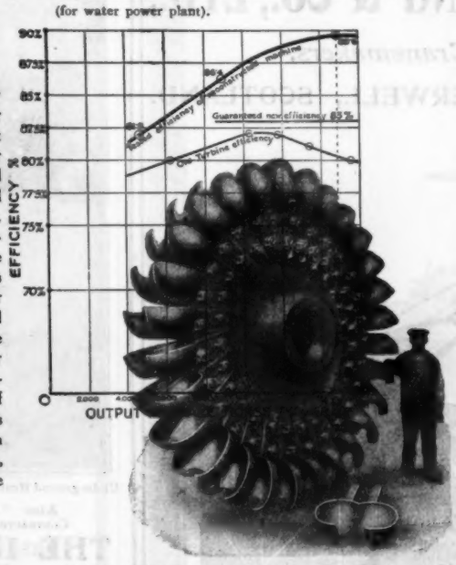
The Citroën Gear Catalogue, the finest issued, will be sent on request.

THE CITROËN GEAR Co., LTD.,
22, Buckingham Gate, London, S.W. 1.
672

BOVING & CO., LTD.,

Manufacturers of
WATER TURBINES,
PIPE LINES, VALVES, GOVERNORS, etc.
(for water power plant).

EFFICIENCY in Water Turbines is of even greater importance than in most machines as water power is often very limited and must therefore be utilised to the fullest extent. Good design and workmanship are therefore prime essentials for this class of work and water power users are invited to study the remarkable result we obtained after re-designing and re-building five pairs of old type Pelton Wheels for Turbines, each developing 16,000 B.HP., with the remarkable result as shown.



HEAD OFFICE:
Dept. 5, 599
56, Kingsway,
London, W.C. 2.
Telephone: Holborn 6420.
Telegrams: JENORTEN, PHONE, LONDON.

TRADE **W-J** MARK.
ELECTRIC TOOLS
Wet and Dry BENCH GRINDERS
Fitted with Ball Bearings throughout.

An excellent tool for Garage work or Repair shop.

Equipment consists of—
Totally enclosed ball bearing, dust-proof motor, two 8 by 1 wheel guards, adjustable water container with sight water level, switch and cable length.
The tank is detachable, and the machine can be readily converted to a double dry grinder or for buffing and polishing. 879

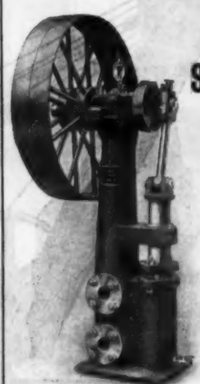
WHITE, JACOBY CO., LTD.,
HEAD OFFICE AND WORKS:
Bayham Place, Camden Town,
LONDON, N.W. 1.
Telephone No.: NORTH 2066.

Electric **CRANES** Electric **CAPSTANS**

ROYCE 700

D.C. **DYNAMOS** & **MOTORS**
Royce Ltd., Trafford Park, Manchester.

PUMPS



Belt or Steam Driven
Vertical or Horizontal

RAM PUMPS FOR MINES.

804

FEED-WATER HEATERS.

SEND US YOUR ENQUIRIES.

THOS. SHORE & SONS, LTD.,
ETRURIA, STOKE-ON-TRENT.

SIEMENS CO SMS LTD PROCESS
ESTD TRADE MARK 1872
"HALLSIDE"

CONTRACTORS TO—
BRITISH ADMIRALTY, WAR DEPT., and FOREIGN and COLONIAL GOVERNMENTS.

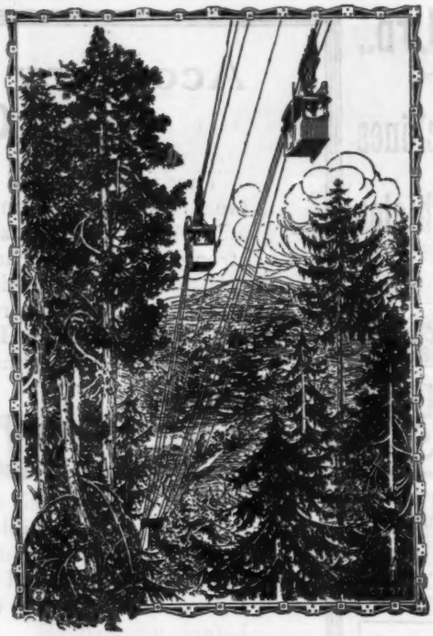
Manufacturers of—

MILD STEEL PLATES, ANGLES, Zed Bars, Tees and all forms of Sectional Bars required for Ship, Boiler, and Bridge Building, and other constructive purposes.
CASTINGS of all kinds and largest sizes for Ship Stems, Sterns, Posts, Anchors, Rudders, &c.
RAILS, BILLETS, FORGINGS.
AXLES of highest quality, to meet the requirements of Home and Colonial Railways.
TYRES.—Locomotive Carriage and Wagon, to all requirements.
SPECIAL STEEL of all kinds for constructive purposes.

THE . . .
STEEL COMPANY of SCOTLAND
LIMITED.
23, ROYAL EXCHANGE SQUARE,
GLASGOW.
TELEGRAPH ADDRESS "STEEL" GLASGOW.
8314

JOHN RUSSELL & CO., LD
WALSALL.
LAPWELDED AND SOLID-DRAWN
TRADE MARK. **TUBES** TRADE MARK.
9663
FOR LOCOMOTIVE AND OTHER BOILERS
AND
GENERAL ENGINEERING PURPOSES
ON ADMIRALTY LIST OF CONTRACTORS.

MARSHALL, FLEMING & CO., LTD.,
Engineers and Cranemakers,
9076
MOTHERWELL, SCOTLAND.



2500 Miles of plant built up to date.

Largest Works on the Continent.

Catalogues in all languages.

CERETTI & TANFANI
(SOCIETA ANONIMA),
MILAN (Bovisa), ITALY.
Capital of the Company 10,000,000 Lire.
788
ROPEWAYS — monocable, bicable, tricable — for the transport of material and passengers.
FUNICULAR RAILWAYS — TELFERAGE.

"IRONITE" ENTIRELY BRITISH
REGISTERED TRADE MARK.
664
BRAND CEMENT FOR FLOORING
Makes CONCRETE FLOORS Wear Proof, Dust Proof, Water Proof, Grease Proof.

Underground Heating Chamber 10ft. below Ground rendered tight with "Ironite" on Floor and Walls.

Also "IRONITE" Brand CEMENT for WATERPROOFING.
CONTRACTORS TO WAR OFFICE, ADMIRALTY, AND OTHER GOVERNMENT DEPARTMENTS.

THE IRONITE COMPANY, LIMITED,
(Managers—S. THORNELY MOTT & VINES, Ltd.),
11, Old Queen Street, Westminster, LONDON, S.W. 1.
Telephone—No. 5618, VICTORIA. Telegrams—THORMOTVIN, VIC., LONDON.
88, Mosley Street, MANCHESTER.
Tel. No.—MANCHESTER CENTRAL, 6900. Tel. Add.—THORMOTVIN, MANCHESTER.
SOLE INDIAN AGENTS—HEATLY & GRESHAM, Ltd., Calcutta, 6, Waterloo St.; Bombay, 304, Hornby Rd.; Madras and Lahore. SOLE AGENT FOR THE DUTCH EAST INDIES—N. V. TECHNISCH BUREAU "SOENDA." Head Office: Bandoeng. Branch Establishments: Batavia, Soerabaya, Malang, Cheribon and Medan.

HALDEN

New Pattern British Machine-Made Drawing Instruments.

FINEST QUALITY AND FINISH.

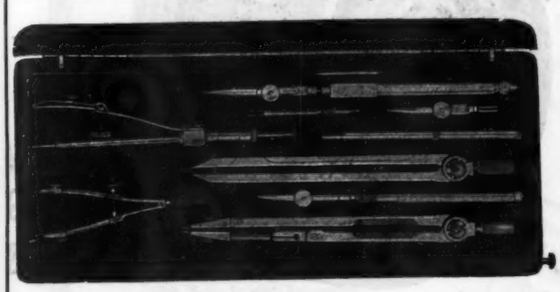
BRITISH THROUGHOUT

No. 1100 Half-Set.

These instruments were first manufactured at the request of a Government Departmental Committee to meet the demands of the Ministry of Munitions.

The design has lately been considerably improved, and our extensive modern plant is now turning out large quantities.

They are supplied loose or in a variety of Cases to suit either the Technical Student or the fully qualified Draughtsman.



No. 1166 Case.

List Price £4 1 0

Sale Price £2 0 6

702

FOREIGN AGENCIES: Australia—A. Brydges-Todd, Aberdeen House, 536, Collins Street, MELBOURNE. South Africa—The Griffin Engineering Co., Ltd., 94, Main Street, JOHANNESBURG. France—A. Deloffre, Palais de la Bourse, LILLE. Argentine—E. P. Bideleux, Calle Chacabuco, 443, BUENOS AIRES.

Fully Illustrated List and Quotations on request.

J. HALDEN & CO., LTD. (DEPT. A 5), 8, ALBERT SQUARE, MANCHESTER.

Depots: LONDON, NEWCASTLE-ON-TYNE, BIRMINGHAM, GLASGOW AND LEEDS.

ICE TANKS

A SPECIALITY.

Prepare for the SEASON

W. P. Butterfield, Ltd.

SHIPLEY.

Yorks., England.

'Grams: "Tanks, Shipley."

'Phones: 35 & 535 Shipley.

9044

Established 1884.

POWER MOND GAS HEATING

TELEGRAMS: "Tetratomic, Stockton-on-Tees."

TELEPHONE: 501, Stockton-on-Tees.

GAS PRODUCER PLANTS

WITH AND WITHOUT

BYE-PRODUCT RECOVERY.

MOND AND LYMN SYSTEMS.

OTHER SPECIALITIES:—

Mechanical Gas Producers.

Suction and Suction Pressure Plants.

Water Gas Plants.

Gas-Fired Furnaces.

Static Gas Washers and Reaction Towers.

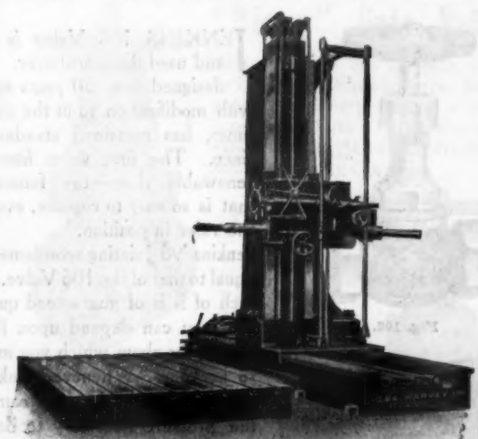
Benzol Recovery and Rectifying Plants.

9114

THE POWER-GAS CORPORATION, LTD.,

PARKFIELD WORKS, STOCKTON-ON-TEES.

HARVEY



Horizontal Drilling, Tapping, & Boring Machines.

Spindles 2", 2¼", 3", 3½", 4", 5", 6" Dia.

G. & A. HARVEY, LTD.

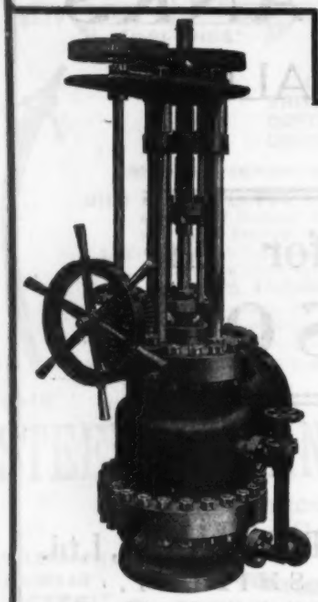
ALBION WORKS,

GOVAN, GLASGOW.

Telegrams "GANDAH."

9016

HOPKINSON'S VALVES



HIGHEST PRESSURES

HIGHEST TEMPERATURES

9669

Double Seated "Centre Pressure" Stop Valve for 10,000 Kw. Steam Turbine.

J. HOPKINSON & CO., LTD.,

Telegrams: "Hopkinson, Huddersfield." **HUDDERSFIELD.** Telephone: 1269 Huddersfield.

A501/1108 **LONDON: IMPERIAL HOUSE, KINGSWAY, W.C. 2.**

Telegrams: "Valvestem, 'Phone, London." Telephone: 705 Regent, London.

ARCHIBALD EDMESTON & SONS, LIMITED.

PATRICROFT.

PATENT FRICTION CLUTCH.

300,000 HP. IN SUCCESSFUL OPERATION.

INVALUABLE FOR DRIVING:

Mining Machinery & Haulage
Saw Mills,
Electric Light and Power.

Concrete and Brick-making Machinery, Flour Mills, Textile Machinery, and Mine Gearing Generally.

FOR STARTING

GAS & OIL ENGINES.

FOR COUPLING SHAFT-ENDS

NOTE: **GENERAL MACHINE PLANING UNDERTAKEN FOR THE TRADE.** 9482

Capacity of Machine. 6 ft. by 6 ft. by 22 ft.

106 and '96—two famous Jenkins lines

Fig. 106.

Jenkins '96 Jointing.

JENKINS 106 Valve is known and used the world over. It was designed over 50 years ago, and with modification to fit the changing times, has remained standard ever since. The first valve fitted with renewable discs—the famous disc that is so easy to replace, even with the valve in position.

Jenkins '96 Jointing won fame almost equal to that of the 106 Valve. Each inch of it is of guaranteed quality—that you can depend upon for just those jobs about which you may feel so nervous. Whenever Jenkins '96 is used for making a steam joint, the pressure necessary to bolt the surfaces together, and the temperature of the steam, cause the packing to vulcanise and form a joint as perfect as if ground in.

72 Page Catalogue Post FREE.

JENKINS BROS. LTD.

(Dept. 1), 537

6, Great Queen Street, Kingsway, London, W.C.2

Works: MONTREAL, CANADA.

POWER PRESSES IN STOCK AND PROGRESS

We have in **STOCK and PROGRESS** for early delivery, a large number of Power Presses, including Drawing Presses, Screw Presses, Blank Cutting, Stamping and Trimming Presses. The following are a few standard types:

OVERHUNG UNGEARED STYLE A. SIZES 3, 4 and 5.
For Blanking, Piercing, Trimming, Shearing, Etc.

GEARED DOUBLE ACTION DRAWING PRESSES.
For Production of Seamless, Drawn Hollow-ware.
Size 5. Punch Stroke 16 in. Drawing 6¾ in. deep.

DOUBLE SIDED UNGEARED PRESSES. STYLE O.
Sizes 2, 3, 4 and 6. Fitted either with or without Side Shears.
For Clipping and Trimming Hot Steel Stampings.

OPEN FRONT UNGEARED PRESS. STYLE B.
Standard Size No. 3.

OPEN FRONT GEARED PRESS. STYLE L S.
Standard Size No. 4.

PATENT PERCUSSION SCREW PRESSES. STYLE H F P.
Sizes 3, 6, 10, Heavy Narrow Frame Type, for production of
Hot Pressings in Brass and Yellow Metals, also Bending, Forging and Stamping Operations.

DOUBLE ENDED PRESSES. STYLE A D.
Size 3. For Punching and Cutting, Trimming Stampings.

Numerous other Presses in Hand. **Write for New Catalogue.** 9713

JOHN HANDS & SONS, LTD.,

ENGINEERS, **CARDIGAN WORKS,** *IRON FOUNDERS.*

'PHONE: CENTRAL 3232 (TWO LINES).
WIRE: MACHINERY, B'HAM. **BIRMINGHAM.**

SMOOTH-ON
TRADE-MARK

IRON CEMENTS

Make permanent repairs of steam, water or oil leaks on iron and steel castings, boilers, engines, tanks, etc.

Every Engineer and Foundryman should have a copy of our new 144 page illustrated Instruction Book. It is free.

WALTER P. NOTCUTT, LTD.,
8, White Street, Moorfields, London, E.C.

Large stocks on hand ready for immediate delivery by

LONDON.
Messrs. F. A. PULLEN & CO., 58, Harleyford Road, Vauxhall, S.E. 11.
BUCK & HICKMAN, Ltd., 2/4, Whitechapel Road, E.

LIVERPOOL.—Mr. JOHN TAYLOR, 10, Strand St.

O 5108

MANCHESTER.
A. DAWES & SONS, Ltd., 131, London Road.
FRED T. HILTON, 94, Hardman Street, Deansgate.

HULL.—J. P. MOFFATT, 454½, Anlaby Road.

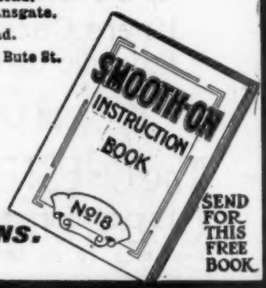
CARDIFF.—A. E. SMITHSON & CO., West Bute St.

GLASGOW.
ANDREW McLEAN & CO.,
109, Main Street, Bridgeton.

WEST BROMWICH.
THE FORDATH ENGINEERING CO., LTD.,
Hamblet Works.

BIRMINGHAM.
Messrs. CLARK & HOWARD,
177, Corporation Street.

BEWARE OF IMITATIONS.



SEND FOR THIS FREE BOOK.

COCKBURN'S
LIMITED
CARDONALD
GLASGOW

The World Renowned Steam Valve Specialists

Codes: A B C 4th Edition. Liebers. | Telephone: 361 Govan (3 lines). | Telegrams: "Cockburn, Glasgow."

SPIRAL SPRINGS
FOR ALL PURPOSES

STEERING GEARS, BUFFER SPRINGS,
A SPECIALTY.
PLEASE ASK US TO QUOTE.

9613

EAST FERRY ROAD ENGINEERING WORKS CO., LTD.

Hydraulic Cranes and Coal Hoists, Hydraulic Presses of all descriptions,
Patent Pneumatic Grain Elevating Machinery.

9763

15 TONS CAPACITY, DOUBLE POWER, FIXED HYDRAULIC CRANE.

General Engineers and Ironfounders. Estimates given for Repairs.

Tel.: HYDROSTATIC, 'Phone, LONDON. MILLWALL, LONDON, E.

OIL & GREASE CUPS - INJECTORS - EJECTORS

VALVES AMERICA'S BEST LUNKENHEIMER QUALITY SINCE 1862 LUBRICATORS

LUNKENHEIMER

"Victor" Gate Valves

This extensive line of gate valves includes the following types: Inside Screw, Stationary Stem; Outside Screw and Yoke; Quick Opening; with Indicator; Gear, Hydraulically and Electrically Operated.

Outside Screw, Extra Heavy Pattern.

Procurable in Standard; Medium; Heavy; or Extra Heavy Patterns, in all standard sizes.

Inside Screw, Medium Pattern.

8069

Iron Body Pattern is regularly furnished with Bronze Mountings but may be had with Nickel Seats and Disc. Also procurable with Cast Steel Body or, for handling alkalies or cyanides which attack brass and bronze, they are obtainable in All Iron.

Write for Catalogue or address inquiries to—

The Lunken Co., Ltd.,
35, Great Dover Street, LONDON, S.E.

Factories—CINCINNATI, OHIO, U.S.A.

Telegraphic Addresses: "LUNKEN, LONDON." "LUNKEN, CINCINNATI."

COCKS-AUTOMOTIVE ACCESSORIES

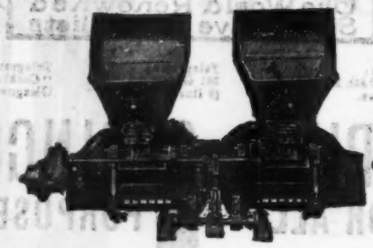
OIL PUMPS - WHISTLES - WATER COLUMNS & GAUGES

PROCTOR'S PATENT SHOVEL STOKER

AND MOVING FIRE-BARS.

14,000 FURNACES FITTED.

10 TO 15% ECONOMY.



20 TO 30% OF 20% MORE DUTY.

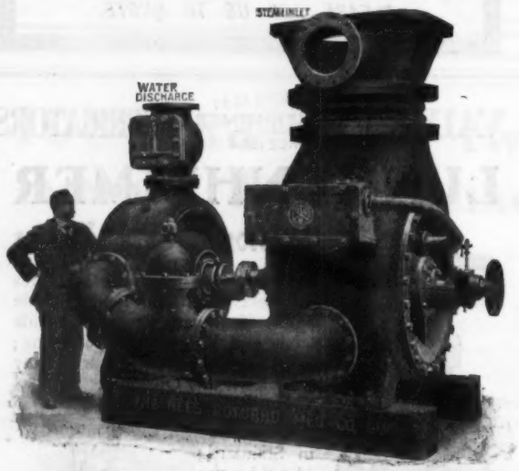
Working on over 1000 Furnaces at many of the largest Steel Works and Collieries.

JAS. PROCTOR LD., Hammerton St. Iron Works. BURNLEY.

SOLE AGENTS FOR FRANCE AND BELGIUM:
The Societe des Perfectionnements a la Vaporisation, 68, Rue de Rome, Paris.

Rees RoTURBo

ROTARY JET CONDENSERS



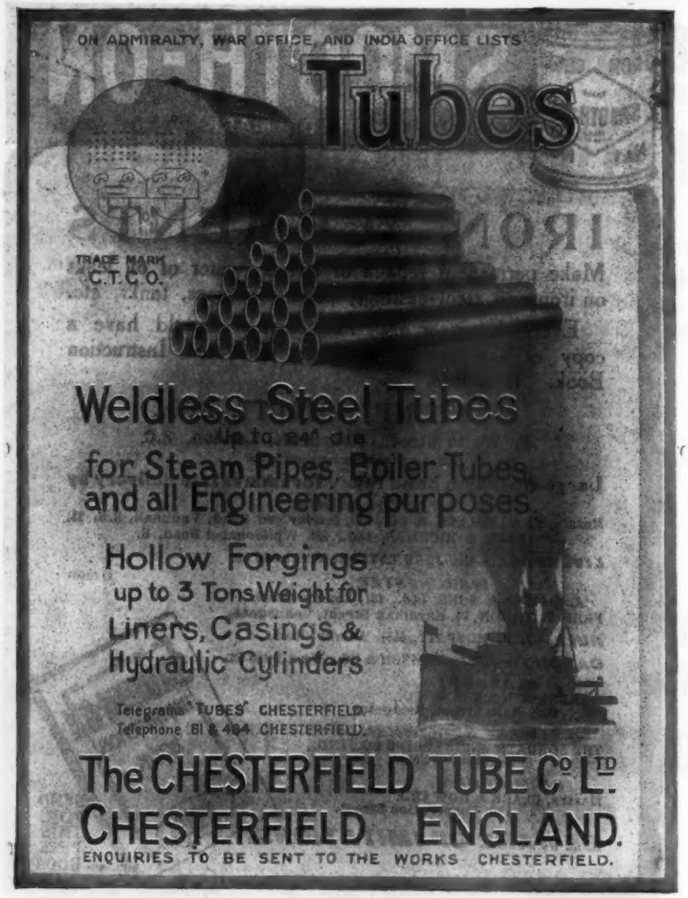
REES RoTURBo Patent Rotary Jet Condenser and Auxiliary Lift Pump

— MADE IN ALL SIZES —

Efficiency Reliability Simplicity

704

The Rees Roturbo M'fg. Co., Ltd.
Hydraulic, Electrical and General Engineers,
Head Office and Works: Wolverhampton, England.
Representatives in all parts of the World.


ON ADMIRALTY, WAR OFFICE, AND INDIA OFFICE LISTS
Tubes
TRADE MARK C.T.C.O.
Weldless Steel Tubes
up to 24" dia.
for Steam Pipes, Boiler Tubes, and all Engineering purposes.
Hollow Forgings
up to 3 Tons Weight for
Liners, Casings & Hydraulic Cylinders
Telegrams "TUBES" CHESTERFIELD
Telephone 81 & 484 CHESTERFIELD
The CHESTERFIELD TUBE Co LTD
CHESTERFIELD ENGLAND.
ENQUIRIES TO BE SENT TO THE WORKS CHESTERFIELD.

If you are looking out for

Standard Sizes 6 to 50 Gallons.

the PERFECT SYSTEM of storing ALL KINDS of Oil for daily use, you cannot do better than instal

"VALOR" Oil Cabinets.

9490

No Waste. No Leakage. No Smell.

CAPACITY - - 50 30 20 12 6 gallons.
PRICES ON APPLICATION.

For use in Factories, &c., and Establishments where cleanliness and safety are considered.

The Valor Company, Limited,
Aston Cross, BIRMINGHAM.

Coal Economy

Of vital interest to Steam users at the present juncture is the question of Coal Conservation.

THE MUSGRAVE SYSTEM
of mechanical draught as applied to Boilers permits of the use of a lower priced coal at a guaranteed saving in the fuel bill and maintains efficient combustion with the maximum results.

———We also Manufacture———
FANS & HIGH-SPEED ENGINES
for driving same to operate on Dust Exhausting, Drying or Ventilating Plants.

COMPLETE PLANTS DESIGNED & INSTALLED

Please send your enquiries, and expert advice and literature will be gladly supplied.

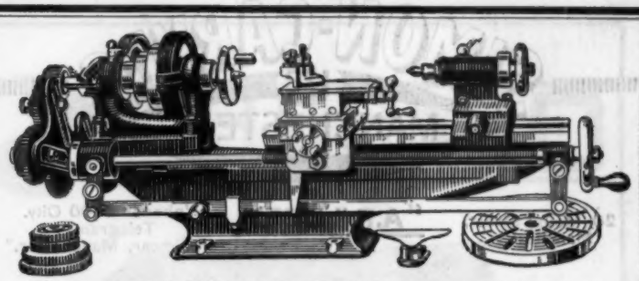
3959

MUSGRAVE & Co., LTD., ENGINEERS,

BELFAST,
MANCHESTER: 42, Deansgate.
CARDIFF: 24, Queen St.
GLASGOW: 11, Bothwell St.
LONDON: Sardinia House, Kingsway.

Telegrams:—CENTIGRAD.
CENTIGRAD.
CENTIGRAD.
CENTIGRAD.
MUSGRAVE, HOLBORN.

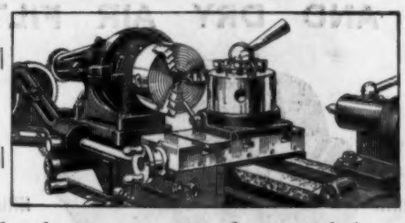
Codes:—LIEBER'S; A.B.C., 5th *Edition*; ENGINEERING TELEGRAPH, 2nd *Edition*.



The Drummond 3½ in. centres Boring and Screwcutting Lathe.

The most economical small manufacturing lathe, and *why*—

Because it costs only £31,
—its accuracy is guaranteed,
—it is strong and adaptable,
—it has special design features.



558

Standard turret attachment in position.

Send a card for full details to

DRUMMOND BROTHERS, LTD.

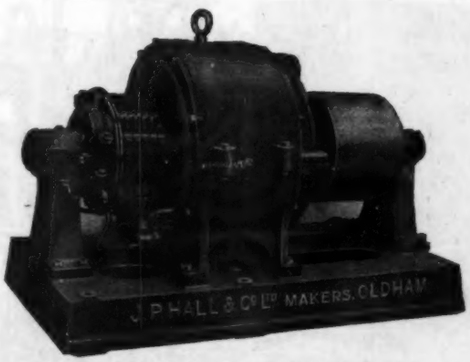
Engle Works, Near GUILDFORD.

J. P. HALL & Co. Ltd.

ELECTRICAL AND GENERAL ENGINEERS.

DYNAMOS & MOTORS

DIRECT or ALTERNATING CURRENT



STANDARD OPEN TYPE DYNAMO OR MOTOR. 9582

FOR MILL AND FACTORY LIGHTING AND DRIVING

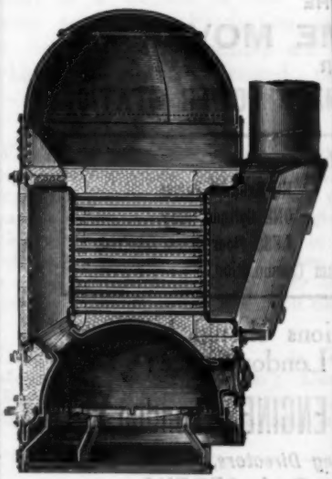
Telephone: 300 Oldham. **Telegrams: Dynamo, Oldham.**

BLACKRIDING IRON WORKS

WERNETH : OLDHAM

COCHRAN BOILERS

PATENT VERTICAL MULTITUBULAR



MADE IN
STOCK SIZES
UP TO
1000 SQ.FT.
HEATING SURFACE

ACCESSIBLE
ECONOMICAL

WRITE FOR CATALOGUE

LAND, MARINE,
WASTE HEAT, ETC

9946

COCHRAN & Co., ANNAN, LTD., ANNAN, SCOTLAND.

Telegrams, 'MULTITUBE, ANNAN' Telephone, No. 2, ANNAN.

SIMON-CARVES LTD
MANCHESTER

20, Mount Street, Manchester. "A.P." DEPT. 'phone: 8200 City. Telegrams: "Simcar, Manchester."

VENTILATING FANS and PLANTS

of every description.

WET AND DRY AIR FILTERS.

9410

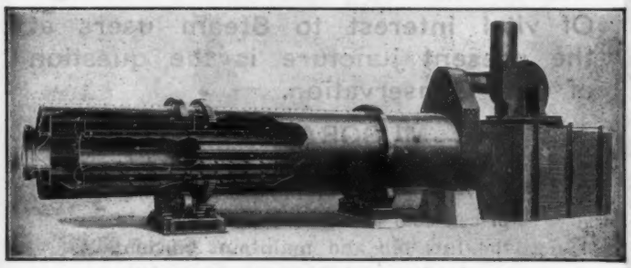
ENQUIRIES INVITED.

ASK FOR CATALOGUE A.P.4.E.

Electrically-driven Fan.

ROTARY DRYERS

(Ruggles-Coles System).



Sectional View showing double shell construction.

These Dryers built to dry at lowest ultimate cost, are being used for drying practically all classes of materials.

They are specially suitable for such substances as

COAL in pulverized fuel plants; SLAG for making tar macadam; SAND in the glass industry; IRON ORE, SEWAGE SLUDGE, LIME, CLAY, CONCENTRATES, etc., etc.

ELECTRO-METALS, LIMITED,

HEAD OFFICE:
Dept. 5,
56, Kingsway,
London, W.C. 2.
(Holborn 6430).

MANCHESTER:
R. MILLETT,
30, Cross Street.
(City 7772).

NEWCASTLE-ON-TYNE:
J. R. STRAKER-WILSON,
3, St. Nicholas Buildings.
(Central 2749).

9387

CARELS

UNIFLOW ENGINE

IS THE

IDEAL PRIME MOVER

FOR

SMALL AND AVERAGE SIZED POWER STATIONS.

Special advantages.

MINIMUM of Working Parts.	NO Exhaust Valves.
MAXIMUM of Overload Capacity.	ONE Cylinder only.
MAXIMUM Flexibility.	LESS Floor Space required.
ECONOMY of Steam Consumption.	

All communications should be addressed to the London Office:

CARELS DIESEL & STEAM ENGINES (London,) LTD.,

Joint Managing Directors,

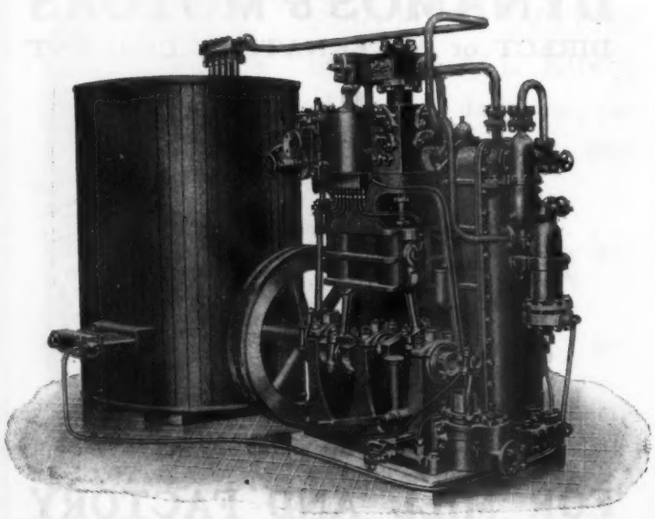
G. E. HEATH. — R. A. SERENA.

Carlton House, Regent Street, 9334
Waterloo Place, London, S.W.1.

Telephone: Regent 3484. Telegrams: Dieselben, Piccy, London.

PATENT MULTIPLE EFFECT CO_2 REFRIGERATING MACHINES

TRADE SMEC MARK.



Multiple Effect Compression greatly increases the output of a refrigerating machine in any climate.

SEAGERS, LD.,

DARTFORD.

9837

HAMPTON & BEEBEE, LTD.

WEDNESBURY,
SOUTH STAFFS.

for

WASHERS

of every description, and
IN ALL METALS
for
AIRCRAFT, MOTOR AND
ENGINEERING TRADES.

SHAFTING COLLARS
HACKSAW MACHINES
HACKSAW BLADES

BRIGHT STEEL BOLTS, NUTS and STUDS.
SQUARE HOLE GRUB SCREWS.
BRIGHT STEEL STRIP.

667

Telephone—
80 WEDNESBURY.

Telegrams—
"WASHERS, WEDNESBURY."

WM. CHALMERS & COMPANY LTD.

RUTHERGLEN SCOTLAND

594

LIGHT DRAFT SHIPBUILDERS

SHEPARD
ELECTRIC CRANES & HOISTS

With considerably more accuracy

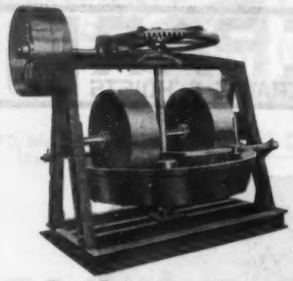
A Shepard Electric Hoist and one man do the work of many in a fraction of the time—and with considerably more accuracy. Production is increased and the costs of handling and assembly are reduced to a minimum—which makes for increased profits to the manufacturer—or lower costs of a commodity to the consumer.

We offer foreign correspondents the service of our engineering department, which is capable and willing to help in the solution of any hoisting and conveying problem you may have. It will facilitate matters if, when writing, you will give us the following information, Electric current available; direct or alternating (if alternating, give voltage, phase, and periods); heaviest load to be carried; distance load is to be carried; kind and quantity of material to be handled, and a sketch of your plant or layout you have in mind.

Electric Travelling Cranes, 1 to 50 tons; Electric Hoists and Monorail Cranes ½ to 30 tons; Double Monorail Track; Electric Winches; and Cargo Handling equipment for docks and ships. Send for catalogue describing complete line.

SHEPARD ELECTRIC CRANE & HOIST CO.
General Offices & Works:
30, Church Street, New York. 696
London, England. **Melbourne, Australia.**

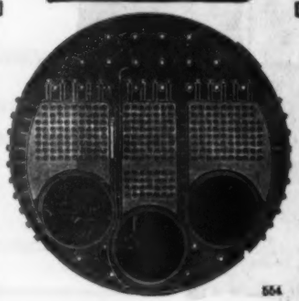
PRATCHITT BROS.
Engineers, CARLISLE.



ENGINE DRIVEN MORTAR MILL.

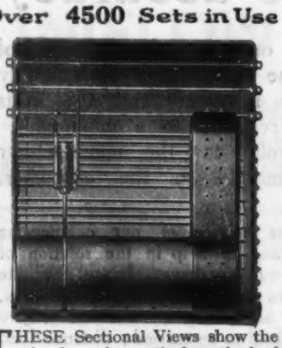
ALSO MAKERS OF— 4157
RAM PUMPS, DISINTEGRATORS
Colliery and Chemical Manure Machinery.

BRUNDRIT
PATENT
Temperature Balance



554

THE
AUTOMATIC CIRCULATOR
For Marine & Land
BOILERS
Over 4500 Sets in Use



THESE Sectional Views show the simple and practical method of fitting BRUNDRIT'S Patent TEMPERATURE BALANCE in Marine Boilers. No drilling or structural alteration is necessary and the boiler can be cleaned with the apparatus in position. . . . . .

BRUNDRIT'S Patent TEMPERATURE BALANCE has been adopted by the leading Shipowners and Shipbuilders of the world, and has proved effective in preventing leakages, reducing repair accounts and promoting a thorough circulation.

Over 4,500 sets have been fitted, including all the boilers of the "Aquitania," "Mauretania," and other ocean liners, also large Cargo and Coasting Steamers, Trawlers, Tug Boats, Dredgers, Launches, etc. . . . . .

The BRUNDRIT TEMPERATURE BALANCE has no valves or working parts, and is entirely automatic. . . . *Working models may be seen by arrangement.* . . . . . .

JOSEPH BRUNDRIT
Sole Patentee,
44 Water St. LIVERPOOL.

Rawhide Pinion and Cast Iron Mitre Wheel on Test.

Our work is up to a standard, not down to a price.

SPUR, BEVEL, HELICAL, and WORM gearing "Durangus" and "New Process" Rawhide Pinions.

Complete Reduction Sets supplied.

George Angus & Co. Ltd.,
Power Transmission Engineers, 517
Angus Gear Works,
NEWCASTLE-UPON-TYNE.
Branches at:—London, Liverpool, Leeds, Manchester, Birmingham, Cardiff, Glasgow and Johannesburg.

REINFORCED CONCRETE

Bridges, Wharves, Jetties, Reservoirs, Warehouses, Factory Buildings, etc.

PRELIMINARY DESIGNS AND ESTIMATES SUPPLIED WITHOUT CHARGE OR OBLIGATION.

JETTY AT PURFLEET for Messrs. Jurgens Ltd., 1175 feet long, on 390 Concrete Piles.

CHRISTIANI & NIELSEN

SPECIALISTS IN DESIGN AND CONSTRUCTION.

Established 1904 — *Contractors to Admiralty and Colonial Governments.*

Offices - - - 74, Victoria Street, Westminster, S.W. 1.
Tel.: 3868 VIC.

BRANCHES AT:
PARIS, COPENHAGEN, STOCKHOLM, CHRISTIANIA, BUENOS AIRES, Etc.

789

SHIP'S STERN CASTING MACHINED AND FINISHED COMPLETE.

CAST STEEL.

By Siemens-Martin and Crucible Processes of every description.

TO PASS ADMIRALTY, LLOYD'S, BOARD OF TRADE OR BUREAU VERITAS TESTS

Castings for Railways, Shipbuilding Yards, Engine Works, Rolling Mills, Iron and Bridge Works, Hydraulic and Electrical Machinery, Mining, River Dredging, Excavating Work.

Specialities :

TOOTH WHEELS & PINIONS used in connection with Cranes, Winches, Capstans, &c.

Cast-Steel ANCHOR HEADS and DREDGER BUCKETS Fit up Complete.

W. SHAW & CO., Wellington Foundry, MIDDLESBROUGH.

Telegrams—"WELLINGTON, MIDDLESBRO." ON ADMIRALTY AND WAR OFFICE LISTS.

London Office—90, Cannon Street, E.C. Representative—A. H. SHARPE.
Office for Manchester and Birmingham Districts, 12, Exchange St., Manchester. Representative—THOS. F. W. DIXON.

Agent for Scotland—H. M. HARPER, 93, Hope Street, Glasgow. 9785
Agent for Leeds and District—G. G. S. GRUNDY, 8, Park Square.

HENRY J. COLES, Ltd.,

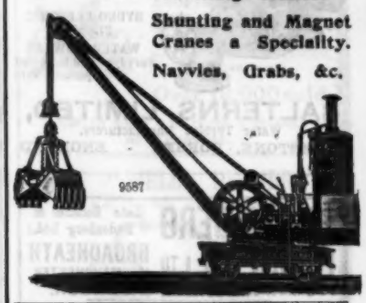
DERBY.

Makers of

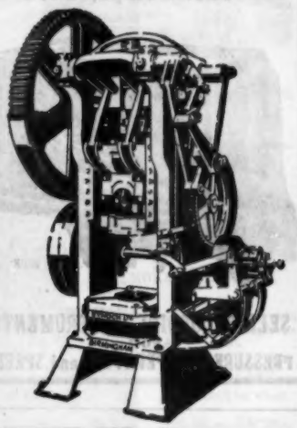
Steam and Electric Travelling Cranes.

Shunting and Magnet Cranes a Specialty.

Navvies, Grabs, &c.



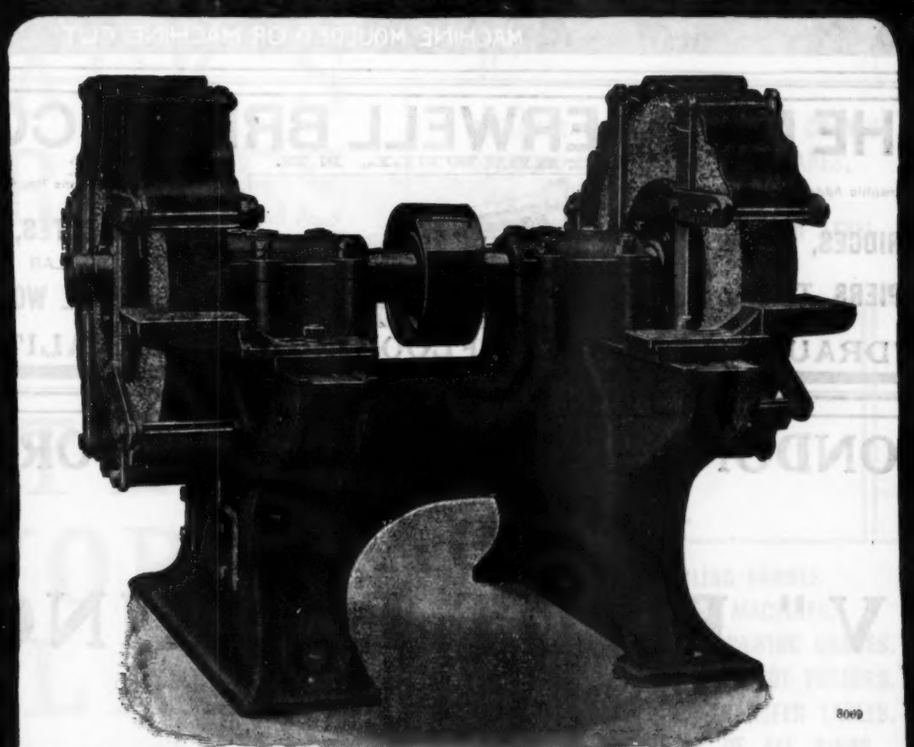
KYNOCH POWER PRESSES



KYNOCH LTD., BIRMINGHAM

(a constituent company of Nobel Industries Limited). 9472

ECONOMICAL GRINDING.



EMERY WHEELS
AND
GRINDING MACHINES.

BRITISH MADE.

L. STERNE & CO., LTD.,

THE CROWN IRON WORKS, GLASGOW.

LONDON OFFICE: DONINGTON HOUSE, NORFOLK ST. W.C.

CLAYTON SON & CO.

LIMITED

WORKS LEEDS WIRES GAS. LEEDS

LONDON OFFICE 5 VICTORIA ST S.W.1

VERTICAL BOILERS

LARGE STOCK READY FOR IMMEDIATE DELIVERY

9497

D

WATER TURBINES

HIGH GRADE PELTON and FRANCIS TYPES.

PATENT UNIVERSAL OIL PRESSURE GOVERNORS.

Delivery from Stock or Progress.

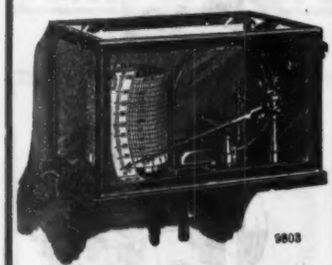
HYDRO-ELECTRIC PLANTS.

WATER POWERS Surveyed and Reported upon. 9676

SALTERNS LIMITED,
Water Turbine Manufacturers.
PARKSTONE, DORSET - ENGLAND.

BUDENBERG GAUGE Co. LTD. (Late Schaffer & Budenberg Ltd.)
BROADHEATH Nr. MANCHESTER.
BRANCHES: LONDON & GLASGOW.

Makers of
PRESSURE GAUGES, Tachometers, Counters, Dial-Thermometers, Test Pumps, &c.



9803

SELF-RECORDING INSTRUMENTS FOR PRESSURE, TEMPERATURE and SPEED.

MACHINE CUT, MACHINE MOULDED GEARS
REDUCING AND ACCELERATING GEARS
OF ALL DESCRIPTIONS. 9748

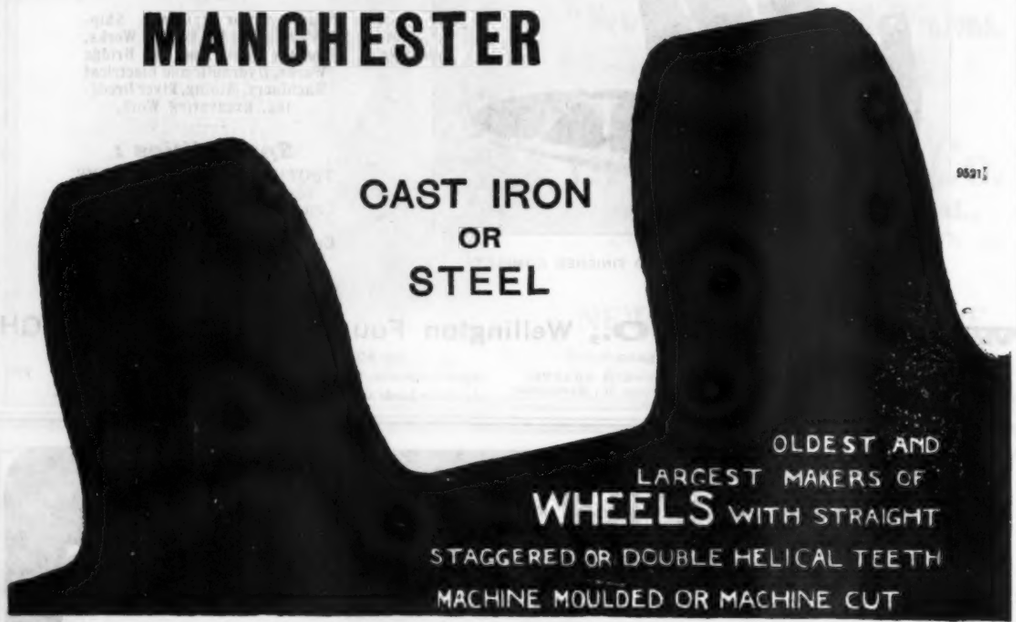
Responsible Agents Wanted where not represented.

LLEWELLAN'S MACHINE CO.,
BRISTOL, ENG.

P. R. JACKSON & Co., LTD.,

SALFORD ROLLING MILLS

MANCHESTER



9931

THE MOTHERWELL BRIDGE CO. LTD.

MOTHERWELL, N.B.

Telegraphic Address—"BRIDGE." National Telephone No. 40.

BRIDGES, ROOFS, PIERS, TANKS,

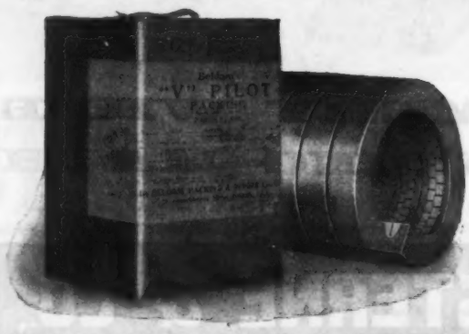
DOCK GATES, AND SIMILAR **STRUCTURAL WORK.** 9733

HYDRAULIC PRESSED FLOORING A SPECIALITY.

LONDON, PARIS and NEW YORK
are now manufacturing

BELDAM'S "V" PILOT PACKING

For Steam *or Water.*



9803

SOLE PATENTEES AND MANUFACTURERS:—

ESTABLISHED 1876.

THE BELDAM PACKING & RUBBER CO., LTD.,

TELEPHONES: AVENUE 5304 & 1982.
29, Gracechurch Street, LONDON. E.C.3.
TELEGRAMS: "VEEPILOT-LED."

ETAB. BELDAM-LATTY, 63, Rue Taitbout, Paris.
TELEPHONE: TRUDAINE 62-84. TELEGRAMS: "BELATTY."

THE NEW JERSEY ASBESTOS CO., 1, Water Street, New York.
TELEPHONE: BOWLING GREEN 9630. TELEGRAMS: "VEEPILOT."

DROP FORGINGS
UPSETTER FORGINGS
HYDRAULIC FORGINGS

— LET US QUOTE FOR YOUR REQUIREMENTS —

THE SCOTTISH STAMPING & ENGINEERING COY., LTD.
AYR, —— SCOTLAND.

Telegrams: STAMPINGS, AYR.
Telephone: 166 AYR.

9871

JACK'S CRANES

OVERHEAD ELECTRIC TRAVELLING CRANES.
OVERHEAD HAND TRAVELLING CRANES.
LOCO. STEAM CRANES.
ELECTRIC WHARF CRANES WITH LEVEL LUFFING GEAR.

STEEL WORKS PLANT

PATENT PLATE HANDLING CRANES.
OPEN HEARTH CHARGING MACHINES.
INGOT CHARGING AND DRAWING CRANES.
LADLE CRANES. INGOT PUSHERS.
ROLLER RACKS AND TRANSFER TABLES.
AUXILIARY MACHINERY OF ALL KINDS.

ALEXANDER JACK & CO., LIMITED,

WHITEGATES ENGINEERING WORKS, 688
MOTHERWELL.

London Office: 11, PANCRAS LANE, E.C. 4.
Newcastle Office: MIDLAND CHAMBERS, 17, WESTGATE ROAD.
Telephone: No. 150 MOTHERWELL.
Telegrams: CRANES, MOTHERWELL.

ADOPTED by 26 Governments. Supplied to 500 British & Foreign Railways and all Leading Builders and Contractors, Engineers, Docks, Railways, etc.

Over 18,000 sold.

500 to 2,500 c.p. from Tar Oil or Kerosene.

THE "WELLS HEATER."

Wallwork and Wells Patents.

TYRE EXPANDING, BENDING, STRAIGHTENING, SETTING, SHRINKING, &c.

A variety of patterns according to requirement.

WELLS' OIL GAS GENERATING LAMPS.

Light from Kerosene or Petroleum, without wick

NO SMOKE OR SMELL.

Perfect Safety. No Explosive Naphtha used.

Thousands Sold.

Unaffected by wind.

No. 12 ... 3 hours.
" 13 ... 5 "
" 14 ... 7 "

KETTLE TORCH LAMPS.

THE MINER'S FAVOURITE.
THOUSANDS SOLD. No. 18.

Used exclusively by De Beers, Randt Mines, etc.

Also largely used by Contractors, Corporations, Collieries, etc.

LARGE FLAMING LIGHT.

WELLS' TORCH LAMPS.

For Sperm, Rape, Colza, or other heavy Smokeless Oil. Also used for Kerosene.

No. 5, ½ pint, Hook No. 3.
No. 5a, ¾ pint, Hook No. 3.
No. 5s, 1 pint, Hook No. 3.

ENGINEER'S HAND LAMPS.

897

For Kerosene, Petroleum, or Paraffin.

No. 4 ½ pint.
No. 4a ¾ pint.

WELLS' LATHE CANS.

LATHE CAN IN TWO SIZES.

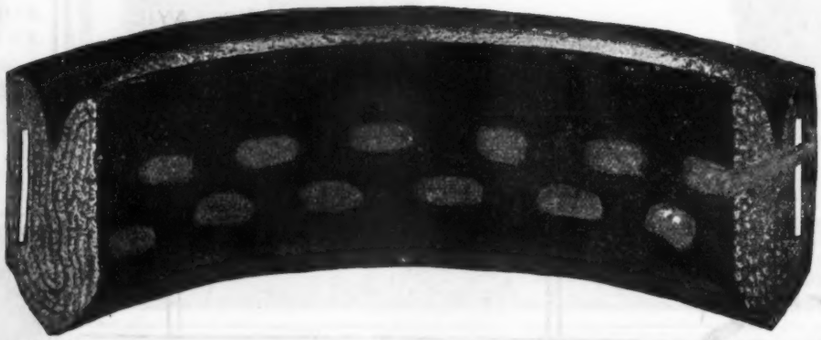
These Oil Drip Cans are supplied with best brass universal fittings.

Small size, 6¼ in. high by 5 in. diam.

Large size, 8 in. high by 7¾ in. diam.

A. C. Wells & Co. 102 Midland Rd., London ST. PANCRAS, N.W. 1.
Works: Carnarvon St., MANCHESTER.

WALKER'S LION PACKING TRADE MARK



The KING OF PACKINGS

FOR ALL PRESSURES OF STEAM AND WATER

9611

WRITE FOR CATALOGUE NO. 3 TO—

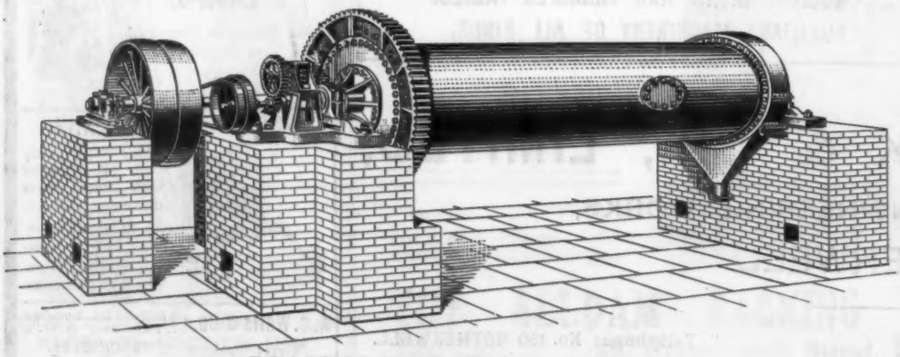
JAMES WALKER & CO., LTD. LION WORKS, GARFORD STREET, WEST INDIA DOCK RD., LONDON, E.14.

TELEPHONE—EAST 4253 (3 LINES). TELEGRAMS—"LIONCELLE, POP, LONDON."

WM. JOHNSON & SONS (Leeds) LTD.,

Crushing & Grinding Specialists,

ARMLEY, LEEDS.



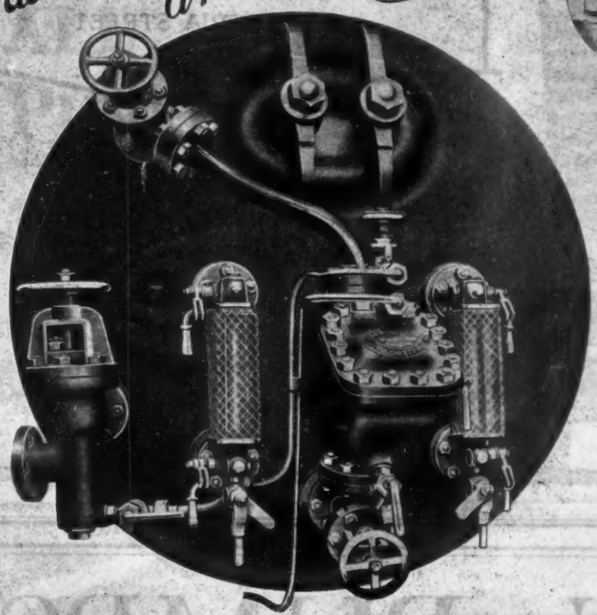
"DRAGON" TUBE MILL. 20 sizes.

9816

CEMENT PLANTS.
PLASTER OF PARIS PLANT.
COAL BRIQUETTE PLANT.
BRICK AND TILE MACHINERY.
MINING MACHINERY.
SPELTER WORKS PLANT.
CRUSHING, GRINDING, SCREENING AND DRYING INSTALLATIONS.

MUMFORD'S
PATENT AUTOMATIC
FEED WATER REGULATOR

A Powerful Factor for Safety and Economy



FEED REGULATOR AND CHECK VALVE ON END OF STEAM DRUM

H.M.S. "HOOD"

HAS BEEN FITTED TO OVER 500 VESSELS OF THE BRITISH & FOREIGN NAVIES FOR BOILERS AGGREGATING OVER 10,500,000 I.H.P.

ALSO TO

WHITE STAR Cos:—
R.M.S. "MAJESTIC"

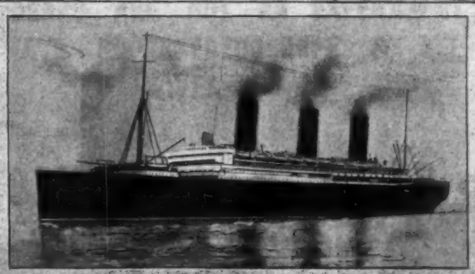
CUNARD Cos:—
R.M.S. "BERENGARIA"

CANADIAN PACIFIC Cos:—
R.M.S. "EMPRESS OF AUSTRALIA"

P & O Cos:—
R.M.S. CAP POLONIO

AND MANY OTHERS

THE WORLD'S LARGEST SHIP



R.M.S. BERENGARIA

A. G. Mumford, Ltd. *Engineers*, COLCHESTER.

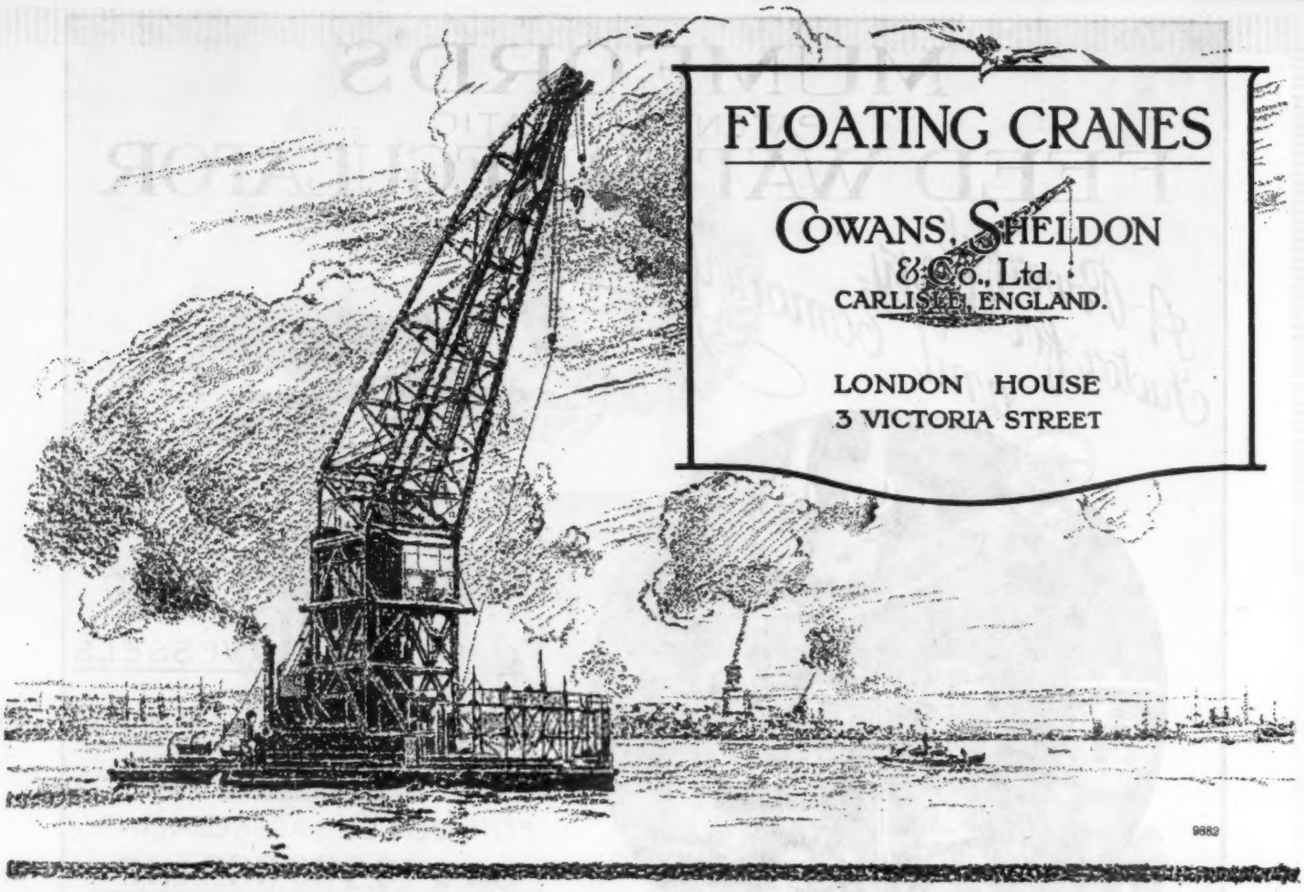
8374

ADMIRALTY, WAR DEPT. AND COLONIAL USES

HYDRAULIC LEATHERS

THE BRITISH SPECIALISTS LEATHERS COMPANY (ALTRINCHAM) LIMITED, ALTRINCHAM

9061



FLOATING CRANES

COWANS, SHELDON & Co., Ltd.
CARLISLE, ENGLAND.

LONDON HOUSE
3 VICTORIA STREET

9882

PEARN PUMPS

for all purposes.

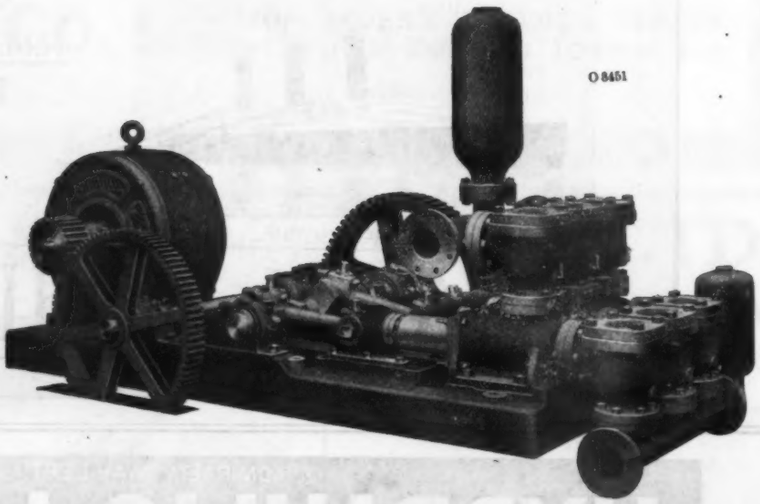
Steam, Belt or Motor drive.

DRY VACUUM PUMPS.
WET VACUUM PUMPS.

CATALOGUES ON APPLICATION.

FRANK PEARN & CO., Ltd.,
Manchester, S.E.

Telegrams: Pumps, Manchester.
Telephone: 2289 Central.



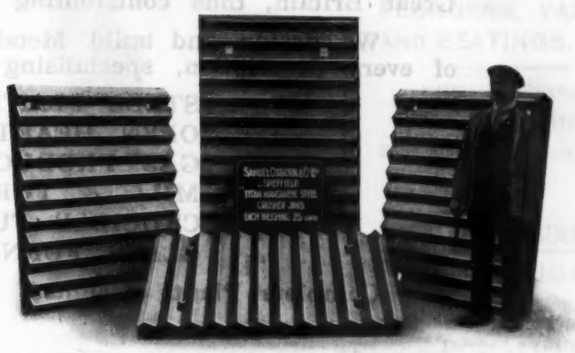
O 8451

HORIZONTAL TREBLE RAM PUMP, DRIVEN BY ELECTRIC MOTOR.

LONDON: 49, Queen Victoria Street, E.C. GLASGOW: P. & W. MACLELLAN, Ltd., 129, Trongate,
NEWCASTLE-ON-TYNE: LINDSAY & WARD, 90, Pilgrim Street.

STEEL CASTINGS

FOR ALL PURPOSES.



(3). "TITAN" MANGANESE STEEL CRUSHER JAWS FOR CRUSHING ROAD BALLAST, &c.

SAMUEL OSBORN & CO., LIMITED,

CLYDE STEEL WORKS, SHEFFIELD.

London Office: 32, Queen Victoria Street, E.C. 4.

DBS

THESE GEARS ARE NOT AN EXPERIMENT; THEY HAVE SUPERSEDED ROPE & BELT DRIVES IN

FACTORIES, CEMENT MILLS, RUBBER WORKS, DYEWORKS, &c.

WE CAN SUPPLY GEARS FOR EVERY CLASS OF DRIVE.

WE SOLICIT YOUR ENQUIRIES.

DAVID BROWN DBS & SONS (Huddd) LTD

LOCKWOOD · HUDDERSFIELD

GLASGOW OFFICE:—19, WATERLOO STREET.

"THE SUCCESS OF A STEEL PLANT DEPENDS UPON ITS EQUIPMENT."

"Wincott" Furnaces of high efficiency, robust design and construction, have been installed in the leading Steel Plants of Great Britain, thus contributing to their success.

We design and build Metallurgical Furnaces and Equipment of every description, specialising in:—

STEEL PLANT LAYOUTS,
OPEN HEARTH FURNACES,
GAS PRODUCER PLANTS,
MILL & FORGE FURNACES,
CRUCIBLE FURNACES,
GLASS FURNACES, Etc.

Complete Plants designed, supplied, and erected.

G. P. WINCOTT, Limited,

Engineers and Furnace Designers,

ATTERCLIFFE ROAD, SHEFFIELD.

REPORTS. TESTS. INVESTIGATIONS.

CASTINGS

Telegrams:
"HALEFO, TIPTON."
"FAIRMAN, GLASGOW."
"MALSTEEL, MANCHESTER."
"UMALSTEELO, CHISK, LONDON."
Codes: A.B.C. 5th Edition, Marconi International.

Malleable Iron & Steel Alloy

610

Telephones:
72 TIPTON (PTE. EX.).
210 GLASGOW (CENTRAL).
752 MANCHESTER (Chorlton-cum-Hardy).
1065 LONDON (CHISWICK).

(TIPTON) THOMAS L. HALE LTD.

"MEMBERS OF THE NATIONAL UNION OF MANUFACTURERS (INC.)."

DUDLEY PORT, TIPTON, STAFFS.

SUPPLIERS TO H.M. ADMIRALTY, WAR OFFICE, MINISTRY OF MUNITIONS, LEADING RAILWAYS, SHIPBUILDERS, MOTOR CAR MANUFACTURERS, ENGINEERS, Etc., Etc.

A. G. MUMFORD, L^D.,

Culver Street Engineering Wks., COLCHESTER.

"Favourite" DONKEY PUMPS

With Great Improvements for Heavy Pressures.

A. MUMFORD No 1 SA COLCHESTER
A. MUMFORD No 1 SA COLCHESTER
A. MUMFORD No 1 SA COLCHESTER
A. MUMFORD No 1 SA COLCHESTER
A. MUMFORD No 1 SA COLCHESTER

2330

GUN-METAL PLUNGERS, VALVES AND SEATINGS.

VERY STRONG. WELL FINISHED.

Made Single and Double Acting.

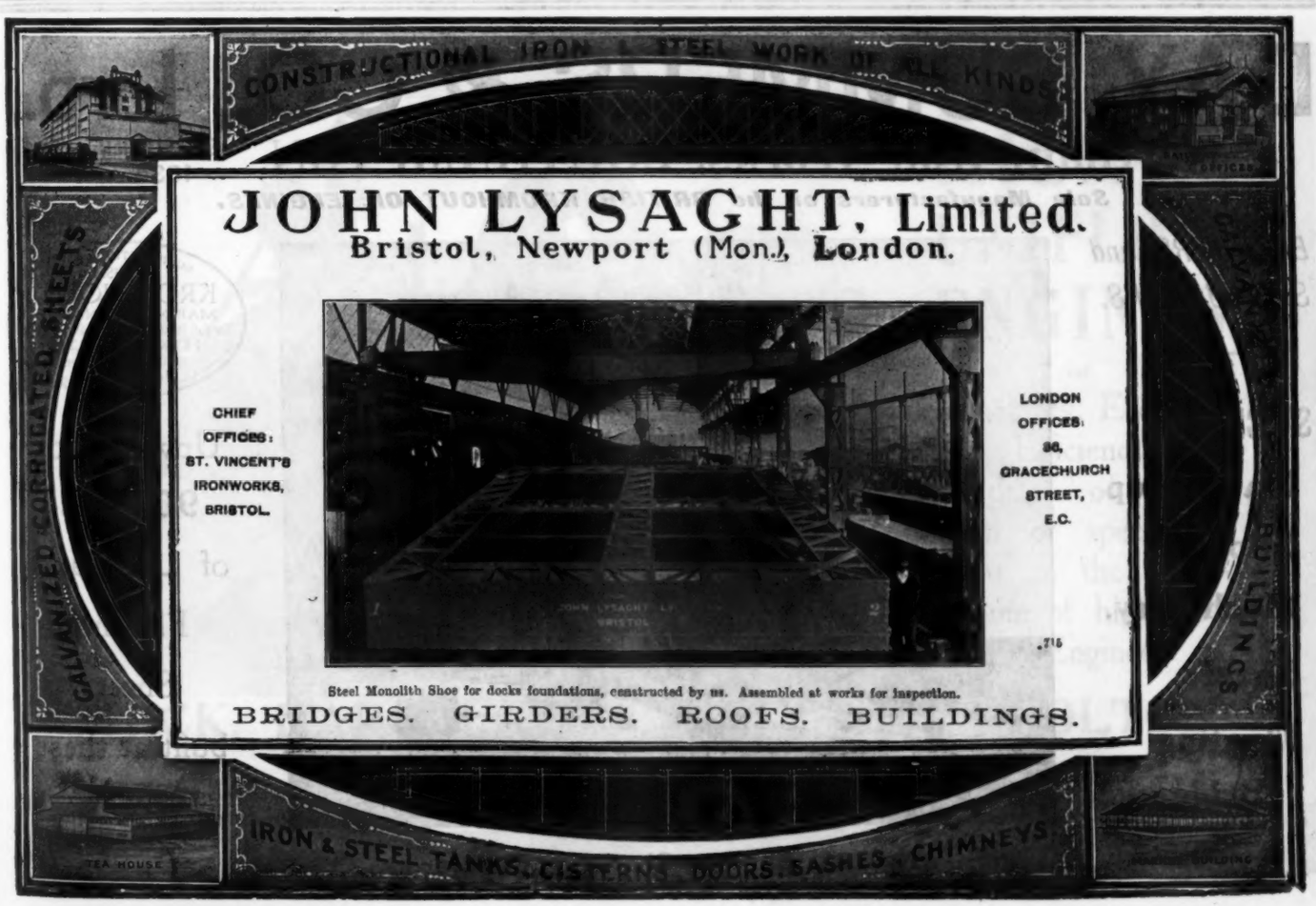
Also "DUPLEX" & "SIMPLEX" STEAM PUMPS.

Vertical and Horizontal for BOILER FEED—AIR and CIRCULATING and all duties for which pumps are required.

FULL PARTICULARS AND LISTS ON APPLICATION.

Sizes.	Single-Acting.							
	No 0.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Diameter of Ram	1	1¼	1¾	2¼	2¾	3¼	3¾	4
Diameter of Cylinder ...	2	2½	3	3½	4½	5½	6½	7
Length of Stroke	2	2½	3	4	5	6	6	6
Gallons per hour	90	130	210	440	660	1000	1080	1280
N.HP. of Boiler	4	8	16	30	45	70	62	80

Sizes.	Double Action.					
	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
Diameter of Ram	1½	2	2½	3	3½	5
Diameter of Cylinder ...	3	3½	4½	5½	6	7
Length of Stroke	3	4	5	6	6	6
Gallons per hour	420	600	1250	1890	2160	4000
N.HP. of Boiler	32	70	90	120	150	250


CONSTRUCTIONAL IRON & STEEL WORK OF ALL KINDS
GALVANIZED CORRUGATED SHEETS
BUILDINGS
IRON & STEEL TANKS, CISTERNS, DOORS, SASHES, CHIMNEYS

JOHN LYSAGHT, Limited.

Bristol, Newport (Mon.), London.

CHIEF OFFICES: ST. VINCENT'S IRONWORKS, BRISTOL.

LONDON OFFICES: 36, GRACECHURCH STREET, E.C.

715

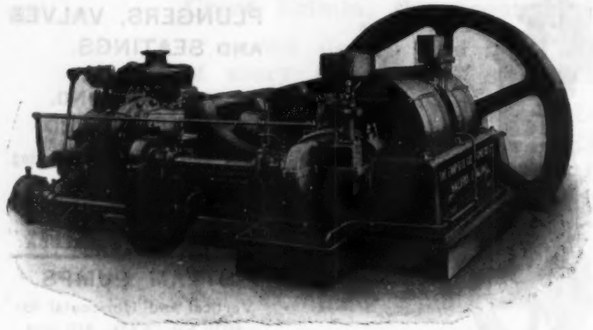
Steel Monolith Shoe for docks foundations, constructed by us. Assembled at works for inspection.

BRIDGES. GIRDERS. ROOFS. BUILDINGS.

CAMPBELL

COLD STARTING HEAVY-OIL ENGINES.

CONVERTIBLE ENGINES TO RUN ON OIL OR GAS
INTRODUCED AND SUPPLIED IN 1914.



THE CAMPBELL was the FIRST COLD STARTING Heavy Oil Engine and the FIRST to be constructed as a CONVERTIBLE Engine for Running either on Oil or Gas.

An Engine of this type will make use of any seasonal supply of Refuse Fuel or ensure continued working in case of failure of the supply of Fuel Oil.

CAMPBELL SUCTION GAS PLANTS GASIFY ALL KINDS OF WASTE WOOD OR OTHER VEGETABLE REFUSE, AS WELL AS COAL, COKE OR CHARCOAL.

THE CONVERTIBLE ENGINES ALSO WORK WITH NATURAL GAS, TOWN GAS, Etc.

STANDARD SIZES UP TO 500 B.HP. 9865

THE CAMPBELL GAS ENGINE COMPANY, LTD.

HALIFAX, ENGLAND.

LONDON: 73a, QUEEN VICTORIA ST., E.C. 4. GLASGOW: 104, BATH ST. CALCUTTA: C 3, CLIVE BUILDINGS.

DAY, SUMMERS & CO., LTD.,

Northam Iron Works, SOUTHAMPTON.

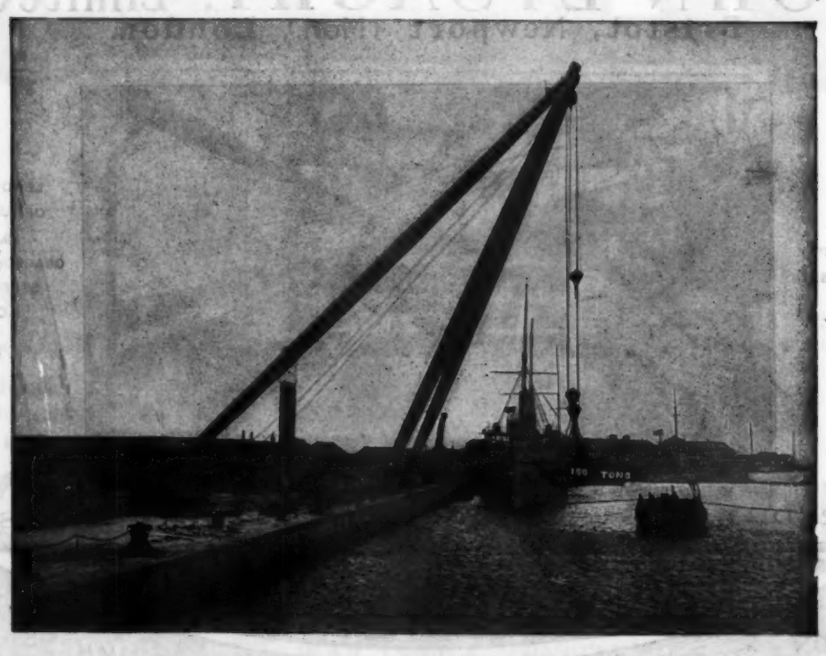
ESTABLISHED 1834.

Sole Manufacturers of the BRITISH KROMHOUT OIL ENGINES.

ENGINEERS and SHIPBUILDERS.

SPECIALITIES:

Hauling-up Slipway Machinery, Sheers, Floating Bridges.



No. 83 Sheers, Chatham Dockyard.
TESTED TO 180 TONS.

MANUFACTURERS OF BRITISH KROMHOUT MARINE OIL ENGINES
For full Particulars, Prices &c. apply to PERMAN & CO. LTD. 82-83, Fenchurch Street, LONDON, E.C. 4

Upwards of **90 Sets** of Land and Floating Sheers built at these Works.

933

OUR experience in the application of Ball and Roller Bearings is always at your service.

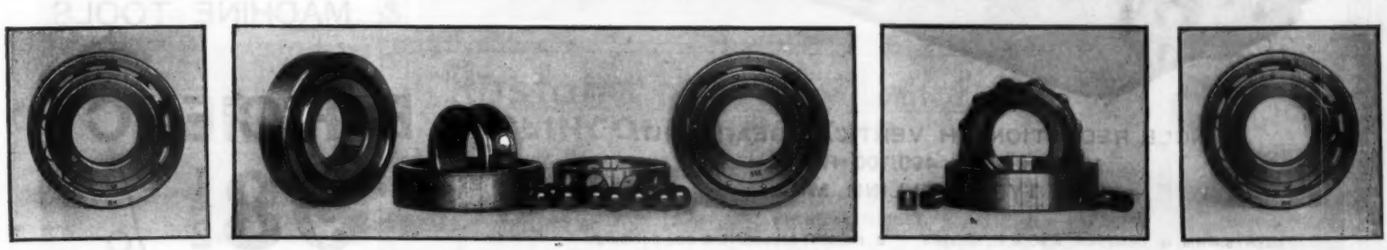
We have a staff of experts here who will gladly advise as to the most suitable size and type of

HOFFMANN BALL & ROLLER BEARINGS

and will also submit drawings showing the best method of application. These people are fully conversant with the best practice in mounting bearings, and their recommendations may be relied on as being absolutely correct.

4615

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX.



9804

330 *I.HP. Uniflow Engine installed in a Paper Mill.*

HICK— UNIFLOW ENGINES

for

Reliability, Economy and Efficiency, the product of many years of specialized effort in the manufacture of high class Steam Engines.

HICK, HARGREAVES & CO., Ltd., BOLTON.

ESTABLISHED 1832.

Telegraphic Addresses { "HICK, BOLTON." "UMSHAWVAPO, FLEET, LONDON."

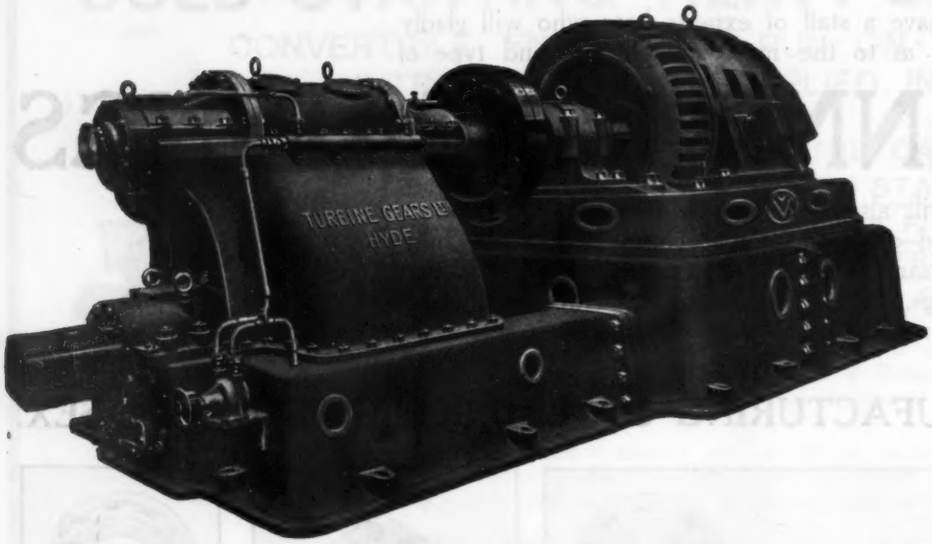
Telephone Nos. { BOLTON—1373-4. LONDON—6288 Central.

LONDON OFFICE: 90, Temple Chambers, Temple Avenue, London, E.C.4.

Telegraphic Codes:—A B C, Fifth Edition; A 1 (1883), Western Union (Universal Edition), Lieber's Standard.

TURBINE GEARS LTD.,
HYDE, CHESHIRE.

Telegrams: "Gears, Hyde."
Telephone: 41 Hyde.



SINGLE REDUCTION DH VERTICAL GEAR UNIT.
1000 HP. 490/100 R.P.M.
FOR TYRE ROLLING MILL.

FOR SILENT POWER
USE
DOUBLE HELICAL GEARS
ON
PUMPS,
HAULAGE,
FAN DRIVES,
ROLLING MILLS,
RUBBER MACHINERY
& MACHINE TOOLS.

EFFICIENCY
98½ %

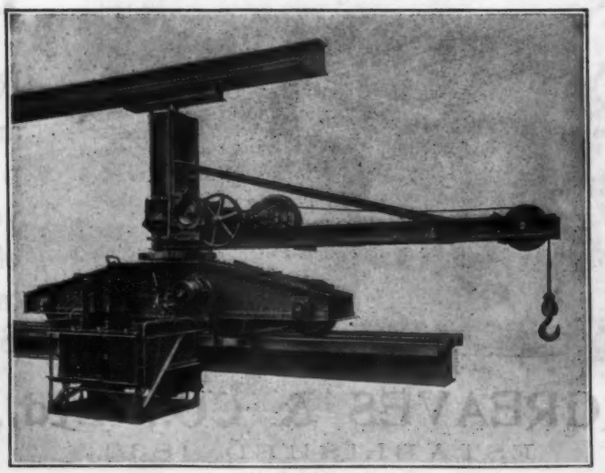
AGENTS.—WM. G. TRAQUAIR, A.M.I.M.E., Glasgow. R. FAUSET, GILLESPIE & CO., Edinburgh. 523
J. R. STRAKER WILSON, Newcastle-on-Tyne. W. M. LYDALL, Huddersfield. F. SAUNDERS, Ltd., Sydney, N.S.W., Australia.

CRANES for ENGINEERING SHOPS.

ALEX. CHAPLIN & Co., LTD.,
GOVAN, GLASGOW.

■ ■ ■

Specialists in Crane Design.



3 Ton 3 motor Electric Mono-Rail Crane.

OVERHEADS
■ ■ ■
PORTAL
■ ■ ■
LOCO-MAGNET.
■ ■ ■

508

Telegrams:
"CHAPLIN," GLASGOW.

London Representative:—James Golder, M.I.M.E., Moorgate Hall, Finsbury Pavement, London.

HIGH CLASS

BOILERS OF ALL TYPES

STEEL VESSELS

CHIMNEYS GAS MAINS

STRUCTURAL WORK

Our works are amongst the finest Boiler Works in existence.

Our experience is unrivalled and we can offer :—

Correct Design,
High Grade Materials,
Best Workmanship,
Prompt Delivery,
Efficient Service at Competitive Prices.

Estimates Free.

Lancashire Boilers
(up to 9 ft. 6 in. dia.)
Cornish Boilers,
Flue and Tube Boilers,
Cylindrical Multitubular,
Oil Well Drilling,
Waste Heat, Loco and Vertical Boilers,
Structural Work,
Steel Vessels,
Chimneys, etc.

9000

Ruston & Hornsby Limited

LINCOLN ENGLAND

Telegrams: Ruston Lincoln. Telephone 580, Lincoln

London 46, Queen Victoria St., E.C. 4.
Glasgow 173A, St. Vincent Street.

Agents in all parts of the World

The MIRRLEES WATSON Co. LTD.

GLASGOW.

Largest Makers in the World of

SUGAR MACHINERY

SPECIALTIES:—

COMPLETE SUGAR FACTORIES.

MODERNISING OF EXISTING FACTORIES.

SEND FOR ILLUSTRATED CATALOGUE.

Codes: Western Union (Universal and 5 Letter Eds.), Liebers, Engineering, A B C (5th and 6th Eds.), A1, Bentleys, and Marconi.

Telegrams: "MIRRLEES, GLASGOW." Telephones: 1780, 1781, 1782 South.

LONDON OFFICE:
MIRRLEES HOUSE, 7, Grosvenor Gardens, S.W. 1.

9-Roller Mill with Krajewski Crusher.

Mills, 34 in. dia.—with Toggle Gear—and Krajewski Crusher, driven by one Engine.

9731

101

"BELFAST ROOF" COVERED WITH "ROK."
Constructed to give up to 100 feet clear span.

ANDERSON'S "BELFAST ROOFS."

THE pioneer lattice girder roofs. Economical, light, and airy. No roof so quickly erected. Can be raised bodily from one storey to another. 9554

Waterproof, fire-resisting, acid, alkali, and vermin-proof when covered with "Rok" Roofing.

Write for estimates, expert advice, and free catalogue.

D. ANDERSON & SON, LTD.
Also Sole Makers of "Sidol" Wood Preservative
BELFAST ROOFS
Covered with
"RoK" ROOFING

Lagan Felt Works, BELFAST. Roach Rd, Old Ford, LONDON.E. Park Rd Works, Stretford, MANCHESTER

Henderson Overheads

Electrically driven Overhead Travelling Crane in Electrical Engineering Works. Load 60-tons with 15-tons auxiliary hoist. Test load 75-tons. Span 67-feet.

COMPETITION!
REDUCE HANDLING COSTS
Inefficient or insufficient cranes mean heavy loss as compared with the best equipment

Henderson Electric Overhead Cranes combine the most modern and efficient design with the very best materials and workmanship. Technical knowledge and experience together with up-to-date manufacturing facilities, which include our own **Steel and Iron Foundries,** have made the name "Henderson" synonymous with Speed, Reliability and Strength.

Robust Construction. Greatly Reduced Prices. Early Deliveries.

Our technical staff is at the disposal of those dealing with mechanical handling problems.

Cranes of all types, Aerial Cableways, Ropeways, Transporters, Hoist Conveyors, Runways.

Write for fully illustrated Catalogues.

LONDON: 17 Cockspur Street, S.W.1. Telephone Gerrard 8983.
MANCHESTER: 33 King Street. Telephone Central 699.
And at Birmingham, Glasgow, Newcastle-on-Tyne, and Sheffield.

Enquiries invited for — HIGH-CLASS — STEEL CASTINGS

JOHN M. HENDERSON & CO
KINGS WORKS ABERDEEN
Telegrams: 'Cranes, Aberdeen. *Telephone No.: Central 3162 (3 lines).*

Ruston-Hornsby

The Car of Quality & Value

POINTS OF MERIT. **2. Economy**

Low running costs single out the Ruston-Hornsby for the man who studies economy.

For while it is sturdily built on sound engineering principles its weight is kept as low as is compatible with absolute safety.

The result is that users of the 16-20 HP. model regularly obtain 25 miles to the gallon of petrol, 1500 miles to the gallon of oil, and from 6000 to 8000 miles per set of tyres.

Although it develops 32 HP. the 16-20 HP. model is moderately taxed at £16 per annum.

PRICES

16-20 HP.		20-25 HP.	
2-Seater	£585	2-Seater	£650
5-Seater	£585	5-Seater	£650
All-Weather Saloon	£850	All-Weather Saloon	£925
Landaulette ...	£870	Landaulette ...	£975

16-20 HP. LANDAULETTE.

For Illustrated Specification write to the Sole Concessionnaires:

C. B. WARDMAN & CO. LTD.

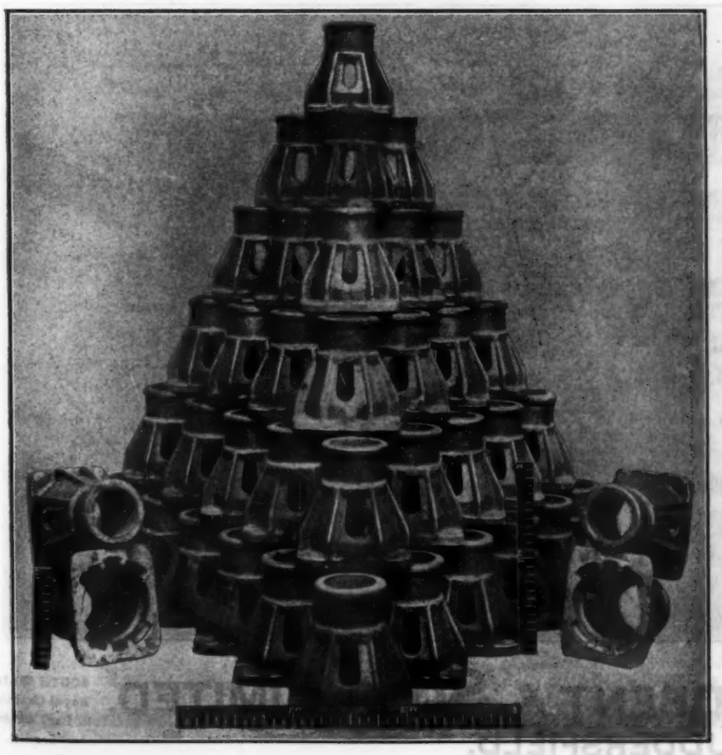
122, Gt. Portland Street, London, W.1.

Telephone: Langham 1530-1. Telegrams: "Rusorncy, Wesdo, London."

Name and address of nearest agent will be sent on application.

MANUFACTURED BY RUSTON & HORNSBY LTD., OF LINCOLN.

THWAITES BROTHERS, LTD.,



London Office:—
CENTRAL HOUSE,
KINGSWAY, W.C. 2.

Head Office and Works:—
VULCAN IRONWORKS
BRADFORD.

卐 卐 卐

STEEL CASTINGS

to Admiralty, Board of Trade, Lloyd's Register, British Standards and other specifications.

ACID ELECTRIC STEEL

Superheater Headers, Valve Bodies, Pipe and Boiler Fittings and pressure work generally.

RAILWAY CASTINGS.

卐 卐 卐

Other Manufactures

STEAM HAMMERS; BLOWERS; CUPOLAS; HOISTS STAGINGS; SAND MIXERS, ETC.

GAUGE GLASSES. PACKING. WATER GAUGES.

If you know "KLINGERIT" the original JOINTING, you already value its sterling qualities:—

EFFICIENCY
DURABILITY
ECONOMY.

When ordering JOINTING from your dealer, specify:—
KLINGERIT.

Klinger Patents,
40, King Street,
Covent Garden,
W.C. 2.
Telephone: Gerrard 4894.
Samples Supplied.

ELECTRIC TRAVELLING CRANES.

EFFICIENT DESIGNS AND ROBUST CONSTRUCTION.

LONDON OFFICE:
SUFFOLK HOUSE,
LAURENCE POUNTNEY HILL,
E.C.

THOMAS BROADBENT & SONS, LIMITED.
HUDDERSFIELD.

SOUTH WALES:
Royal Chambers,
Park Place,
Cardiff.

CRANES FOR RAILWAY GOODS YARDS

STOTHERT AND PITT · LTD
ENGINEERS
: BATH :
ENGLAND.
LONDON OFFICE
38 VICTORIA ST:
S·W·1

FIG. 1287. MANCHESTER.

S&P.
WE OFFER
100 YEARS
EXPERIENCE

D46997

A "GLOBE PNEUMATIC" JOB.

EXCAVATIONS AND ROADWORK.

"G.P.E." PNEUMATIC TOOLS.

TIE TAMPERS
ROAD PICKS
CLAY SHOVELS
CONCRETE BREAKERS
AND
COMPLETE PORTABLE OR FIXED
COMPRESSED AIR PLANT.

"G.P.E." Pneumatic Tools are BRITISH MADE throughout.

THE
GLOBE PNEUMATIC
ENGINEERING COMPANY LIMITED
1, VICTORIA STREET, LONDON, S.W.1.

O 8911

F

ALFRED HERBERT LTD. COVENTRY

AH

IMMEDIATE DELIVERY

The advantage to the buyer of being able to obtain prompt delivery is obvious; the purchase of plant is not usually decided upon until the need has become urgent.

In the present conditions of business there is but little inducement to invest capital in machinery which will not be immediately productive, but when the need of additional equipment does arise, quick delivery is a *sine qua non*.

Realising the importance of quick delivery, we have endeavoured always to carry a representative stock of the machines and tools which we sell.

In periods of good trade it is impossible to avoid being out of stock occasionally of some particular item, but no difficulties of this kind arise at the present time; we have a large and carefully selected stock.

During the past thirty years we have devoted our attention to the selection of such machine tools and accessories as would constitute a comprehensive range and be amongst the best of their respective types.

In this work we have been greatly assisted by the possession of three large machine shops of our own in which everything that we sell can be thoroughly tested under actual working conditions before it is included in our programme.

Only the fittest can survive this process of elimination.

Our own manufactures, coupled with the numerous sole selling agencies which we hold, enable us to offer complete equipment—machine tools, small tools, jigs and accessories—for all machining processes.

We can furnish reliable advice not only on the plant for carrying out such processes but also on the operations which should either precede or supplement the actual machining.

In order that the best results may be obtained from the plant which we supply, a staff of expert demonstrators is maintained; they visit customers' works and give instructions in the efficient handling of the machines and equipment.

In an advertisement of this nature it is impossible to give a complete list of everything which we have in stock. Briefly we offer:—

IMMEDIATE DELIVERY,

RELIABLE ADVICE,

EFFICIENT SERVICE,

COMPETITIVE PRICES,

and therefore solicit enquiries.

9976

DEVELOPMENTS IN FIRTH'S STAINLESS STEEL.

The following list sets out the full range of Firth's Stainless Steels. Descriptive pamphlets and further information will be supplied on request.

1 STAINLESS CUTLERY STEEL.

F FIRTH STAINLESS **H**

Supplied in the softened condition for subsequent hardening, for the manufacture of cutlery, machine blades, optical mirrors, etc., and for all purposes where final hardness is an essential characteristic.

N.B.—Cutlery made of Firth's Stainless Steel, when correctly hardened and tempered, maintains its cutting properties, and may be sharpened when necessary, without affecting its stainless qualities.

2 HIGH TENSILE STAINLESS STEEL.

F FIRTH STAINLESS **G**

Supplied in the heat-treated condition to be machineable, and to comply with the mechanical properties required for specific engineering purposes.

3 MALLEABLE STAINLESS STEEL.

F FIRTH STAINLESS **M**

This form possesses a high degree of malleability. It is specially prepared for cold pressing, and for other purposes where the rust-resisting property is desirable without further heat-treatment. Where excessive cold working is necessary, simple annealing may be required. It is more easily forged than the two preceding forms of Stainless Steel.

4 "STAINLESS IRON."

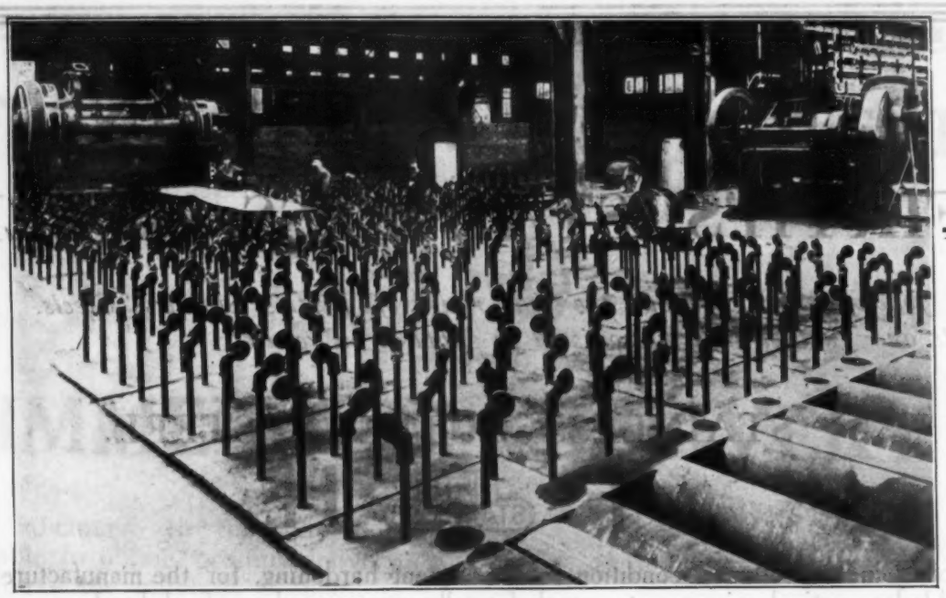
F FIRTH STAINLESS **I**

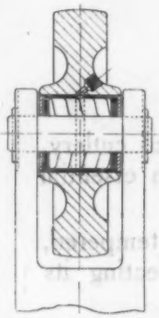
"Stainless Iron" may also be used for cold presswork, etc., and can be used for hand forging when it is desirable to avoid annealing, where the mechanical properties are not required to indicate great strength.

THOS. FIRTH & SONS, LTD.

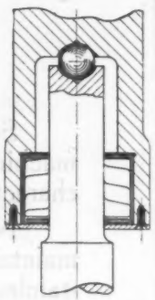
SHEFFIELD.

9830





In the wheel.



In the gooseneck.

MODERN STEELWORKS PRACTICE.

HYATT

ROLLER BEARING EQUIPPED PLATE CASTORS.

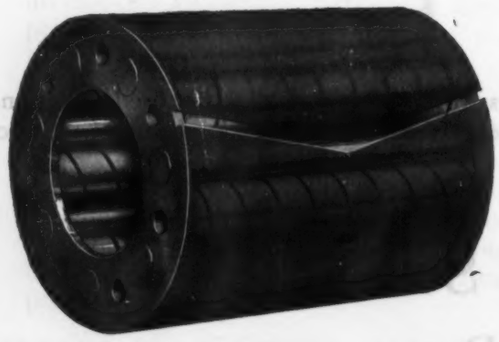
On a bed of Hyatt equipped plate castors two men can handle the largest and heaviest plate throughout the operations of shearing, punching, and forming. The plate can be moved in any direction, swung end for end, and complete control of its motion retained at all times with the utmost ease.

The castor turns at the slightest touch and the wheel revolves with practically no effort.

Plain bearings stick, they refuse to move round to the direction in which you need to move your plate. This results in wear on the wheel. Specify Hyatt and obtain that free turning movement which conduces to the welfare of the two men required.

Plate handling then becomes a continuous operation, free from delays, and the reduction in labour employed lowers the cost per ton produced.

Once packed with lubricant you can forget them.



We shall be pleased to put in the possession of all Steelworks Managers and Engineers any further information desired.

HYATT LTD.,
56, Victoria Street,
London, S.W. 1.

Specify Hyatt Bearings for—Rolling Mills, Blooming Mills, Saws, Rolling Stock, etc. No. 221

ELECTRIC & STEAM CRANES

FOR

SHIPYARDS RAILWAYS

PORTS DOCKS WHARVES

STOTHERT & PITT

LIMITED

BATH, ENGLAND

WORTHINGTON

Worthington Pumps Cannot stick up

because of their special Valve Gear. They will always start as soon as steam is turned on, no matter in what position they were previously stopped. Our Simplex Pump Catalogue fully explains why.

Worthington Simplex Steam Valves automatically take up wear without loss of efficiency, and are therefore always steam tight.

WORTHINGTON PUMPS for
Ballast. General Service.
Boiler Feed. Bilge.

Catalogue on request.
Please quote reference EG/31

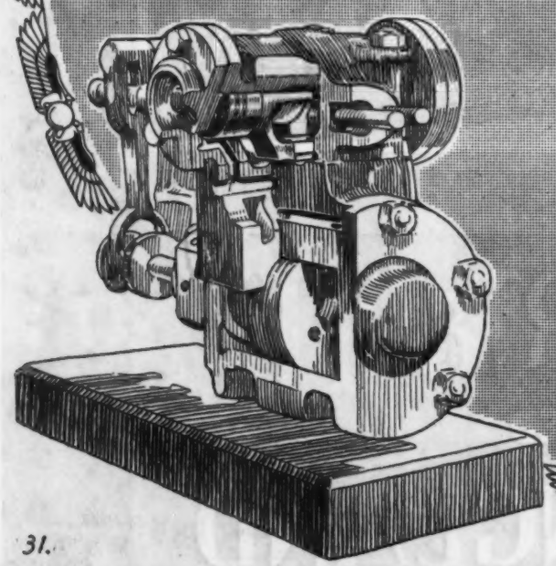
9738

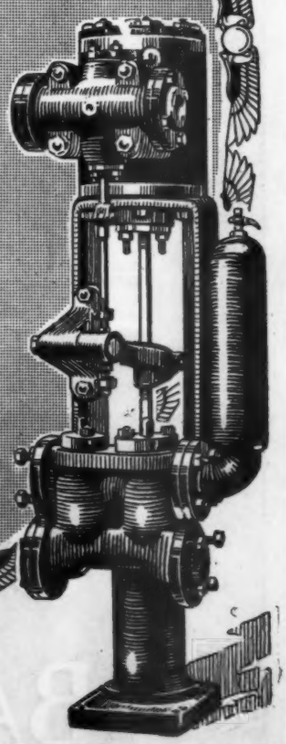
WORTHINGTON-SIMPSON LTD.

Telephones Holborn 3048 3 Lines

Queen's House
KINGSWAY
LONDON-W.C.2
Works-Newark & London

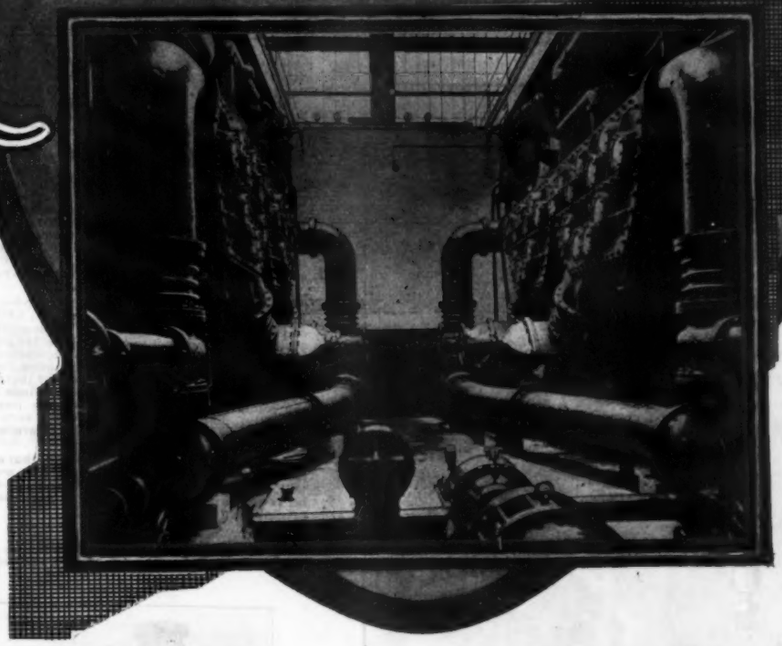
Telegrams Pumping Westcent London.





31.

WEIR UNIFLUX CONDENSING PLANTS for POWER STATIONS



Designed on scientific principles to meet specific conditions and requirements.

Maximum results obtained on less weight, space and surface than any other system.

●

Adopted by leading Municipalities and Electric Power Corporations at home and abroad.

●

ENQUIRIES TO CONDENSER DEPARTMENT.

G. & J. WEIR, Ltd. CATHCART · GLASGOW

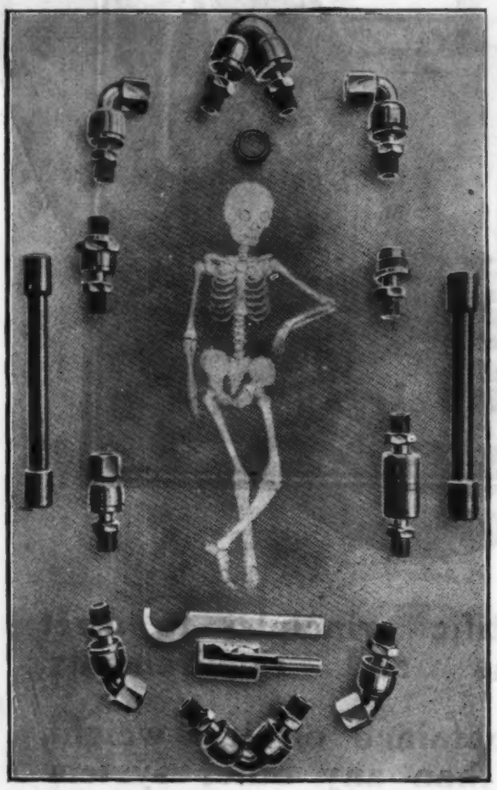
TO ENGINEERS IN ALL TRADES: FLEXSTEL Booklet, sent post free, records original practical money-saving facts.

Dorman's Patented Flexible Joints used with Hose is a guarantee against Hose breakages at acute working angles. FLEXSTEL Joints reduce Hose renewals and maintenance costs.

DORMAN'S

FLEXSTEL

DORMAN'S PATENTED EXPANSIBLE and FLEXIBLE JOINTS in Steel and other Metals from ¼ inch to 12 inch bore. Guaranteed to withstand successfully the highest fluctuating and intermittent pressures for WATER, OIL, GAS, AIR, PETROL, ACIDS, SATURATED or SUPERHEATED STEAM and for many Trades and purposes. Joints are Standardised and Interchangeable. A line can be quickly and easily lengthened or shortened by unskilled labour.



Flexstel designed on the Joints of the Human Anatomy.

TO ELECTRICAL, GAS AND WATER ENGINEERS.

W. H. ROBINS M.I.E.E. Manager. Corporation of Stafford Electricity Works, STAFFORD. 10th March, 1922.

Re **FLEXSTEL.**

Dear Sir,

Some three years ago I told you how satisfied I was with the sample of Steel Pipe Line I had the pleasure of testing at your request. Since that date I have at the request of your Manager carried out quite a number of tests on various sized lines and in every case with perfect results. I have taken the opportunity of putting these samples to practical use and as a result some time ago **placed an order with you in order to dispense with the rubber hose** we have been using in conjunction with our water turbine scaling apparatus on which the pressure is constantly varying from 0-200 lbs. per square inch.

Most of the samples tested have been subjected to high pressure superheated steam, viz., 180 lbs. pressure and a final temperature of over 600 degrees "F." These samples have been put to practical use for long periods and have in every case given no trouble whatever. I have on several occasions had a pipe line connected up to the superheated steam at one end and closed at the other and even under these exceptionally drastic conditions and in spite of the joints being frequently moved the joints have stood perfectly. This test as you know is a very severe one as the joints are subjected to varying temperatures throughout the length under test.

In conclusion I feel confident that once 'Flexstel' is introduced into Electricity and Gas works not only will it give the greatest satisfaction but that uses will be found for it which were never anticipated when the original order was placed.

Yours faithfully,
(Signed) W. H. ROBINS,
Engineer and Manager.

A pair of 6-in. Flexstel Joints supplied to Mapperley Coal Colliery for use in series in their steam main.

Fit new Dorman Engine 8 to 40 h.p. into your old lorry or pleasure car. Saves petrol, oil, and running expenses. Very quickly pays for itself. Thousands sold. Largest Internal Combustion Engine Makers in the British Empire.

Illustrated Engine Catalogue sent post free.

W. H. DORMAN & CO. Ltd., STAFFORD. Specialists in the Designing and Building of Petrol and Paraffin Internal Combustion Motor and Stationary Engines: "The Heart of the Car is the Engine." Makers of Wave Transmission, Mining and other plants. Patent Owners and Makers of the Hele-Shaw Hydraulic (Oil) Clutch.

Head Office and Works: STAFFORD, ENGLAND.
Telephone No.: 181 (3 lines). Telegrams: "Dorman, Stafford."

London Office: ST. BRIDE'S HOUSE, SALISBURY SQUARE, E.C.4
Telephone No.: 8157 Central. Telegrams: "Typify, Fleet, London."

ASSOCIATED BRITISH MACHINE TOOL MAKERS L.TD

17, GROSVENOR GARDENS. LONDON, S.W.1.

MANCHESTER - LEEDS - GLASGOW - BIRMINGHAM

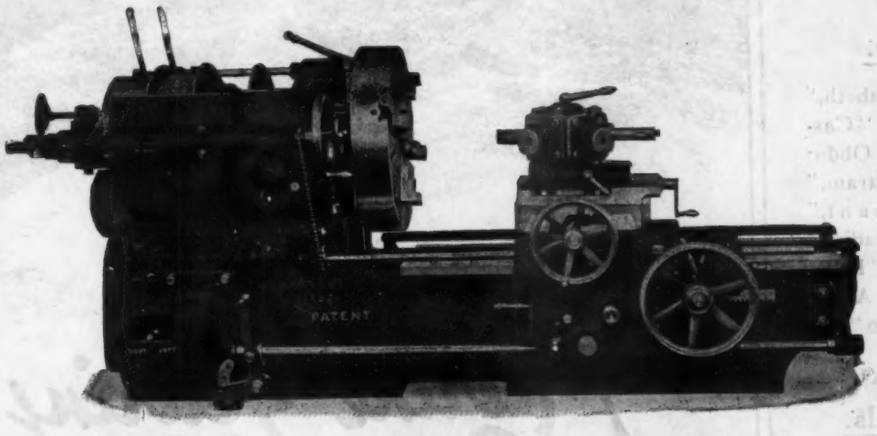
NEWCASTLE - PARIS - BRUSSELS - CALCUTTA

LANG'S ECONOMISERS

In the Turning Department not in the Boiler House.

OUR PATENT VARIABLE SPEED LATHES

will finish a surface in HALF THE TIME taken on a Stepped Cone Lathe.



CORRECT SPEEDS for any diameter.

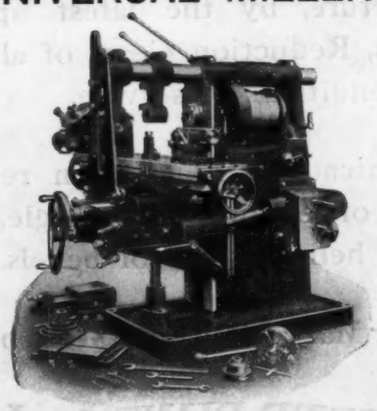
NO COUNTERMOTION.

JOHN LANG & SONS, LATHE MANUFACTURERS,

JOHNSTONE, near GLASGOW.

PARKSON

UNIVERSAL MILLERS



POWERFUL AND RIGID FOR JIG AND TOOL WORK.

ACCURATELY BUILT SO THAT CORRECT LOCATION AND TRUE ALIGNMENTS ARE OBTAINED.

SINGLE PULLEY AND STEP CONE DRIVES.
Two Sizes: 25″ × 8½″ × 16½″ and 36″ × 12″ × 20″.

J. PARKINSON & SON, SHIPLEY, ENGLAND.

You may not want more output, but we do know that you want cheaper output.

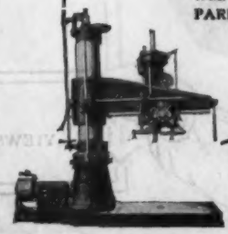
And so far as your drilling is concerned, "Asquith" machines can reduce costs. They have done and are continually doing so in hundreds of the largest shops. And this by reason of the fact that they enable holes to be drilled, tapped, etc., more rapidly than hitherto.

There are hundreds of obsolete drilling machines on which full-wage labour is employed, which cannot give efficient output. "Asquith" drills will treble the output they are giving, and such a national efficiency is essential.

Submit your blueprints without obligation.

ASQUITH

WM. ASQUITH (1920), LTD.,
PARK WORKS, HALIFAX, ENG.



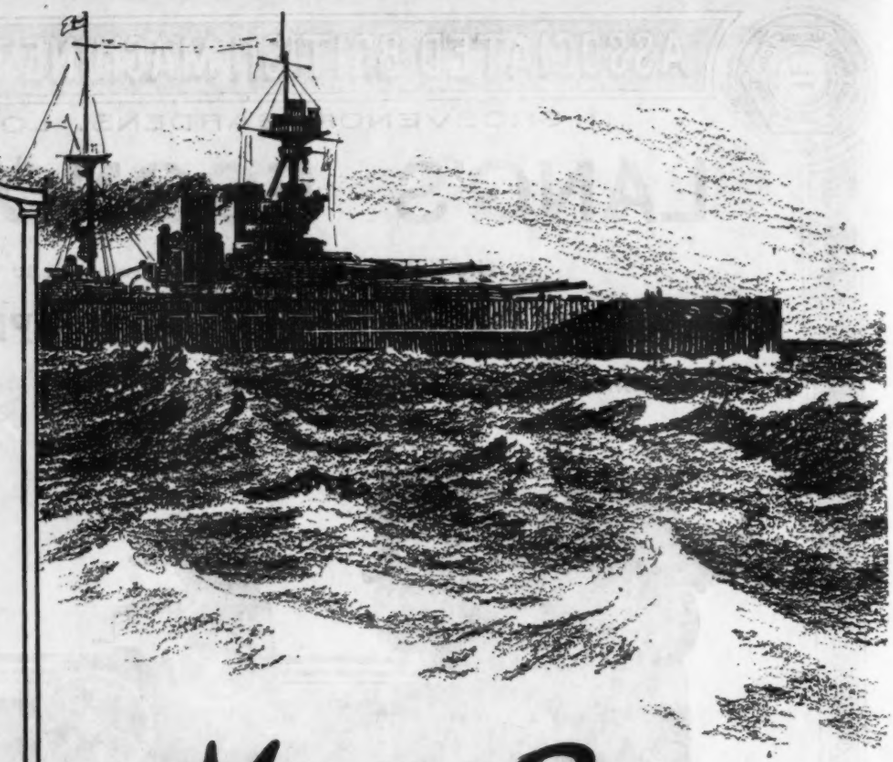
If it's drilling write to Asquith.

THOMAS SHANKS & CO.,
Johnstone.
FOR
HEAVY MACHINE TOOLS.

SEE ILLUSTRATED ADVERTISEMENT, ISSUE OF JUNE 16th.

125

G



List of Ships fitted with

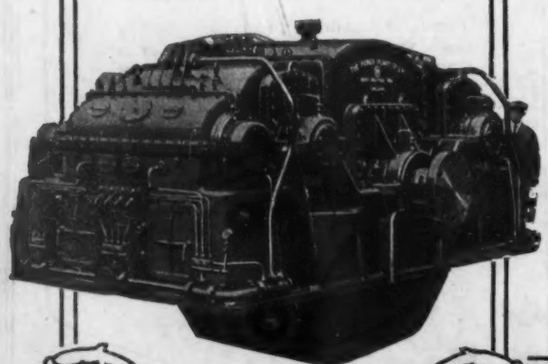
Power Plant Marine Reduction Gears

Naval Vessels.

H.M.S. "Queen Elizabeth," "Malaya," "Curlew," "Cassandra," "Obedient," "Obdurate," "Munster," "Tristram," "Trinidad," "Trenchant," "Vega," "Velox," "Paladin," "Parthian," "Matchless," P. 24, P. 25, P. 18, P. 19, P. 58, Aviso "Lassigny" (French), Aviso "Les Eparges" (French).

Merchant Vessels.

s.s. "Vespasian" "Westmoreland," "City of Canton," "Aurania," "Armagh," "Leitrim," "Riga," "Northumberland," "Wulsty Castle," "Tosari," "Djambi," "Assiout," "Amarna," "L'Orne," "War Weasel," "War Badger," "Mossi," "A.C.B. 8," "Cevennes," "Marne," "Yser," "Les Aulmays," "La Rochefoucauld," "Dinkelstroom," "Reggestroom," "Gouverneur General de Grevy," "P.A. 2," "Gouverneur General de Gueydon."



Marine Gearing of Proved Efficiency

WE are specialists in Reduction Gear Construction. We design and manufacture, by the latest approved methods, Reduction Gears of all types for all conditions of service.

Communicate with us when requiring any kind of gearing—either single, double or triple helical, spurs or bevels.

Write for Marine Turbine Gears booklet.

The POWER PLANT CO., LTD.
WEST DRAYTON, MIDDLESEX.

S. D. & Co.

Telephone: YIEWSLEY 71 (2 lines).

Telegrams: "ROC, WEST DRAYTON."

"ALLIANCE"

FORGING MANIPULATORS

used in conjunction with Forging Presses

(1) Eliminate labour required for manipulating the forgings.

(2) Save much time in handling, thus greatly increasing output.

(3) Save fuel, as the more rapid rate of forging reduces the number of heats necessary.

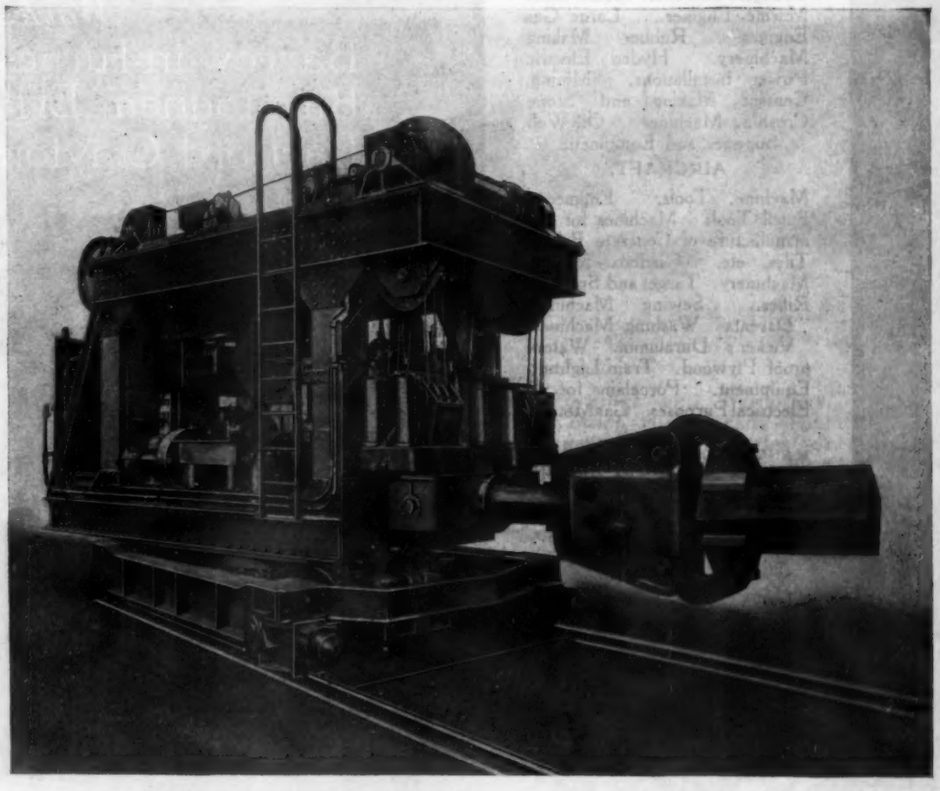
These "mechanical workmen" never tire and are not troubled by intense heat. All motions required for rapid forging are instantly available and under the control of a single operator mounted on the machine.

They are specially suitable for installation with "Davy" Forging Presses as they enable the most to be made of the high speed of working of the "Davy" Press.

Example of Production:

A 1000 ton Press with Manipulator has regularly cogged down **100 tons of 3 ton ingots per 8 hour shift,** the ingots being reduced from 18" square to 9" × 10" and cut up under the press.

By arrangement with the European Manufacturers for the Alliance Machine Co., Messrs. Stothert and Pitt, Ltd., we are acting as selling agents for "Alliance" Manipulators for forging installations.



6 ton Manipulator, Universal Ground Type.

"DAVY" HIGH-SPEED FORGING PRESSES, 100 to 12,000 tons power.
"DAVY" ROLLING MILLS AND STEEL WORKS MACHINERY.
LANCASHIRE, CORNISH AND "BLAKE" WASTE HEAT BOILERS.

Telephone, 4800 (5 Lines)

DAVY BROS. LTD.
SHEFFIELD.
Estabd 1830.

Telegrams, "MOTOR SHEFFIELD"

VICKERS LIMITED

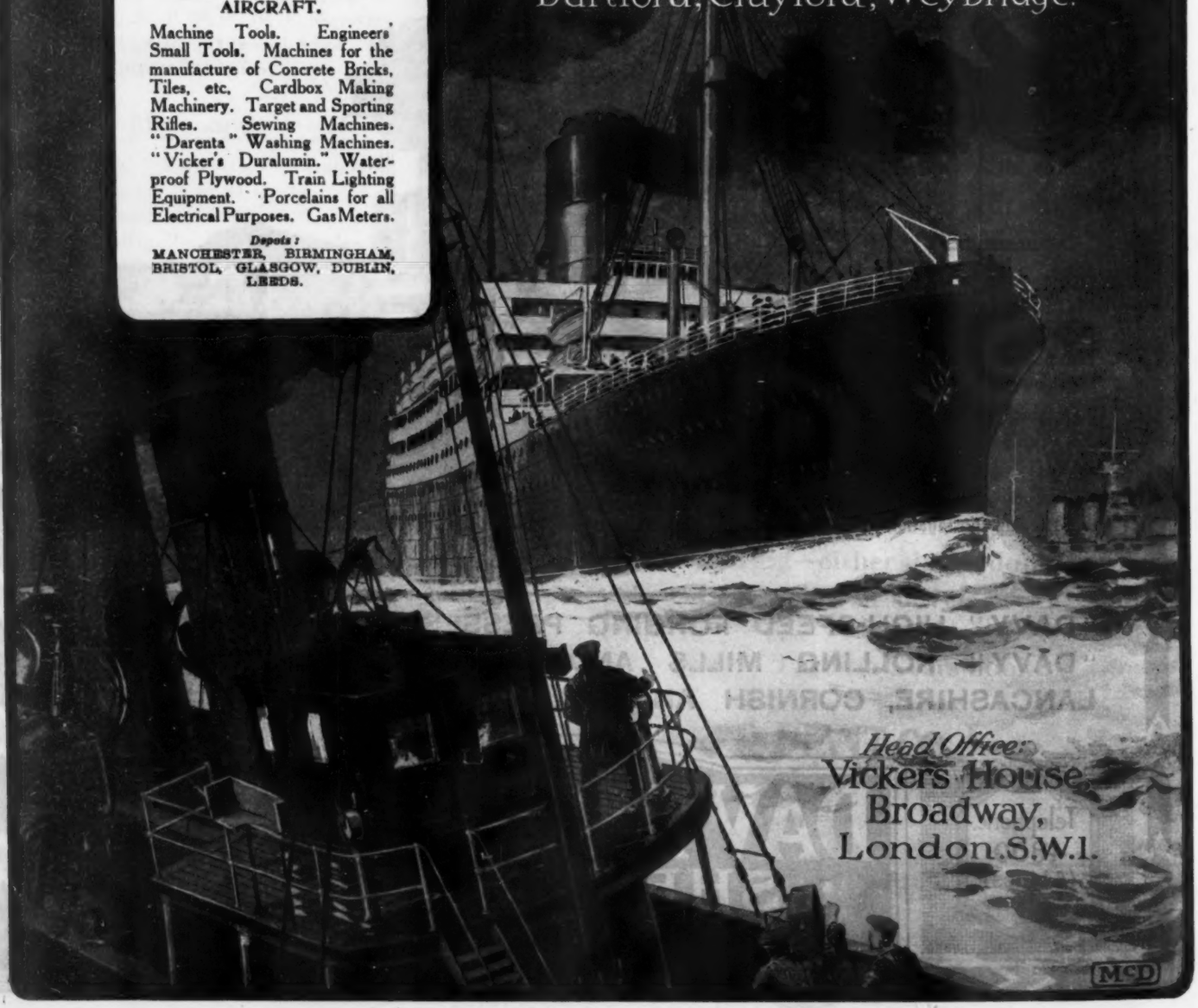
MAIL AND PASSENGER STEAMERS.
Commercial Ships. Floating Docks and Cranes. Icebreakers, Dredgers and other special craft. Marine Engines. Large Gas Engines. Rubber Making Machinery. Hydro Electric Power Installations. Mining, Cement Making and Stone Crushing Machinery. Oil Well Supplies and Equipment.

AIRCRAFT.

Machine Tools. Engineers' Small Tools. Machines for the manufacture of Concrete Bricks, Tiles, etc. Cardbox Making Machinery. Target and Sporting Rifles. Sewing Machines. "Darenta" Washing Machines. "Vicker's Duralumin." Waterproof Plywood. Train Lighting Equipment. Porcelains for all Electrical Purposes. Gas Meters.

Depots:
MANCHESTER, BIRMINGHAM, BRISTOL, GLASGOW, DUBLIN, LEEDS.

Works:
Barrow-in-Furness, Sheffield, Birmingham, Erith, Ipswich. Dartford, Crayford, Weybridge.



Head Office:
Vickers House, Broadway, London, S.W.1.

McD

VICKERS Limited

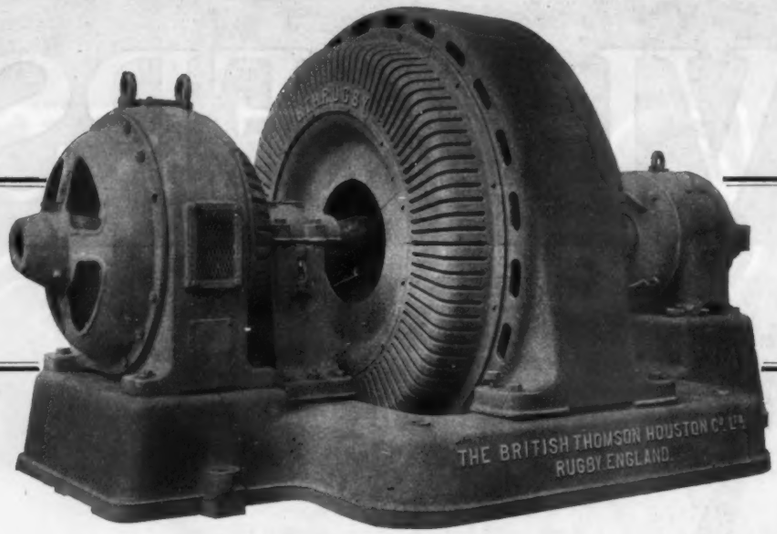
MOTOR CAR
Pressings
Motor Car Springs. Drop Forgings and Stampings. Vanadium High Speed and other High Grade Tool Steels. Weldless Drawn Tubes in all qualities of Carbon and Alloy Steels. Spiral and Straight Toothed Bevel Gear Wheels. Files. Hack Saw Blades. Gauge Plates. Magnets. Jigs. Gauges. Fixtures. Special Tools. Band Saws. Cast Cutters. Surface Hardening by Patented Process.
RAILWAY MATERIAL.
REGISTERED VK TRADE MARK.

DEPOTS:
MANCHESTER: Millgate Buildings, Long Millgate.
BIRMINGHAM: Vickers House, Loveday Street.
BRISTOL: 55, Park Street.

RIVER DON WORKS, SHEFFIELD.
Head Office:
VICKERS HOUSE, BROADWAY, LONDON, S.W.1.

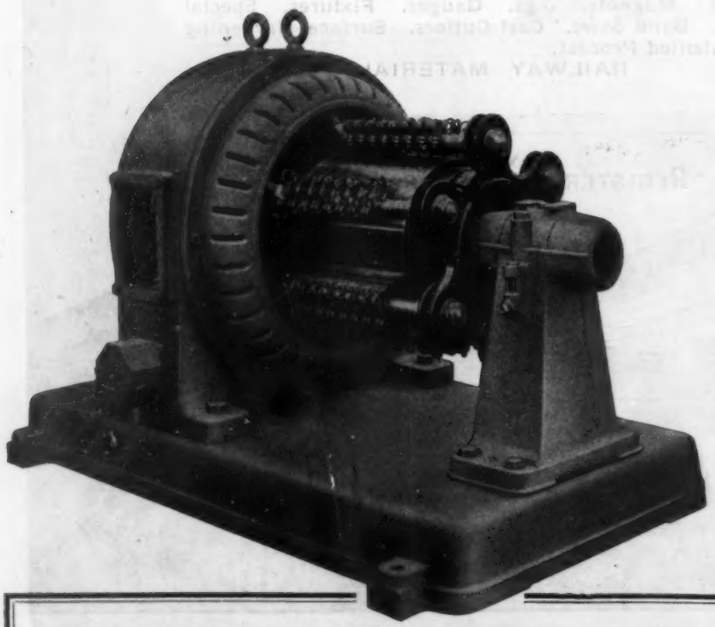
DEPOTS:
GLASGOW: Vickers House, 247, West George Street.
DUBLIN: 32, Nassau Street.
LEEDS: Greek Street Chambers, Park Row.

Improvement of Power Factor



This Company can supply Synchronous Motors, Synchronous Condensers, or Phase Adjusters for the improvement of power factor; the particular machine advocated depending on the special conditions of each individual requirement.

The illustrations show a B.T.H. 1300 KVA Synchronous Condenser and a B.T.H. Phase Adjuster for power factor correction.



B.T.H. Products

Steam Turbines
Turbo-Compressors
Turbo-Exhausters
Generators, A.C. and D.C.
Rotary Converters
Motor Generators
Phase Advancers
Slip Regulators
Switchboards
Industrial Switchgear
Motor Control Gear
Motors, A.C. and D.C.
Electric Locomotives
Train Equipments
Tramway Motors
Magnetos
"Fabroil" Silent Pinions
Flow Meters for Steam, Water, Air and Oil
Lighting Fittings
Mazda Lamps, Vacuum & Gasfilled

The British Thomson-Houston Compy., Ltd.

:: Electrical Engineers and Manufacturers ::
Head Office and Works :: :: Rugby, England.

B T-H

9910

WATER-GAS

(BLUE AND CARBURETTED).

676 SETS OF HUMPHREYS - GLASGOW WATER - GAS PLANT have been (and are being) installed, with a capacity of 481,700,000 cubic feet per diem. Including the work of their American Colleagues, 1623 Sets have been constructed with a total daily capacity of 1,428,900,000 cubic feet.

These Installations will produce the whole World's Consumption of Water-Gas!

WASTE - HEAT BOILERS

MAKE all the STEAM for the Plant. 9771

HUMPHREYS & GLASGOW, Ltd., 38, VICTORIA STREET, LONDON, S.W. I.

Steam Power Plant

For Land and Marine Purposes.

Brotherhood Steam Engines and Turbines offer dependable, low-cost power, and embody the specialised skill of many years' experience.

STEAM TURBINES.

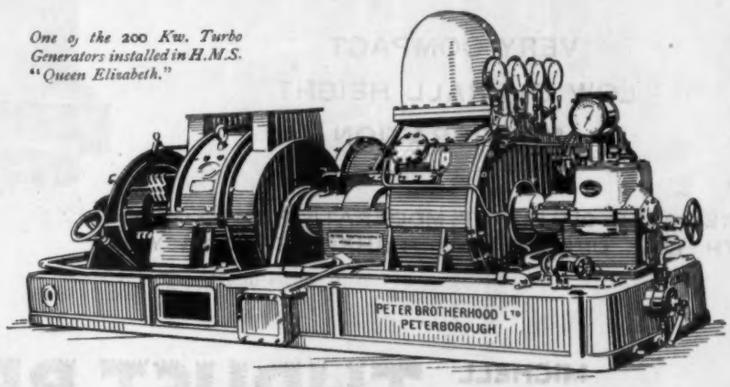
Impulse Type, up to 5000 HP. Special types for back pressure work. Automatic bearing lubrication by ring or pump, according to size.

Simple and Compound STEAM ENGINES

for all purposes, thoroughly reliable in performance and requiring the minimum of attention. Forced lubrication.

Write for Catalogue.

One of the 200 Kw. Turbo Generators installed in H.M.S. "Queen Elizabeth."



PETER BROTHERHOOD LTD

PETERBOROUGH. 724

London Office: Central House, Kingsway, W.C. 2.

ELECTRIC MOTORS

FOR

EVERY PURPOSE.

SOUND IN CONSTRUCTION.
EFFICIENT IN WORKING.
RELIABLE IN SERVICE.
DIRECT CURRENT ONLY.

W. H. ALLEN SONS & CO., LTD.,

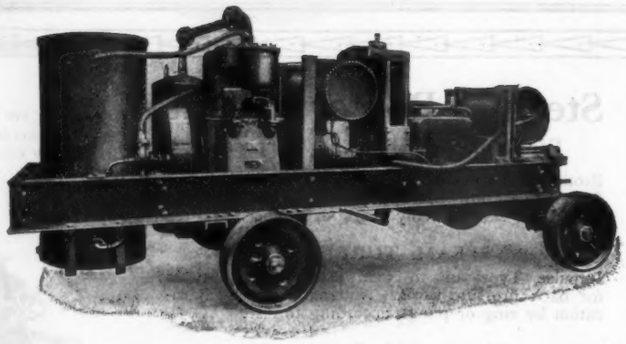
BEDFORD. 9076

BROOM & WADE, LTD

PORTABLE

AIR COMPRESSORS

IN 18 SIZES. SUITABLE FOR DIRECT COUPLING, GEAR OR BELT DRIVING—ALSO STEAM DRIVEN UNITS.



VERY COMPACT
LOW OVERALL HEIGHT
NO VIBRATION

A RELIABLE OUTFIT AT MODERATE FIRST COST, WITH LOW UPKEEP AND HIGHEST EFFICIENCY.

MICHELL PATENT SINGLE COLLAR THRUST BEARINGS

POSITIVE OIL FILM LUBRICATION

THE ONLY RELIABLE THRUST BLOCK FOR HEAVY DUTIES.

INDISPENSABLE FOR HEAVY WORM GEARS, PUMPS, TURBINES, &c.

TEST
Result of Test on 7½ in. Bearings supplied to British Admiralty

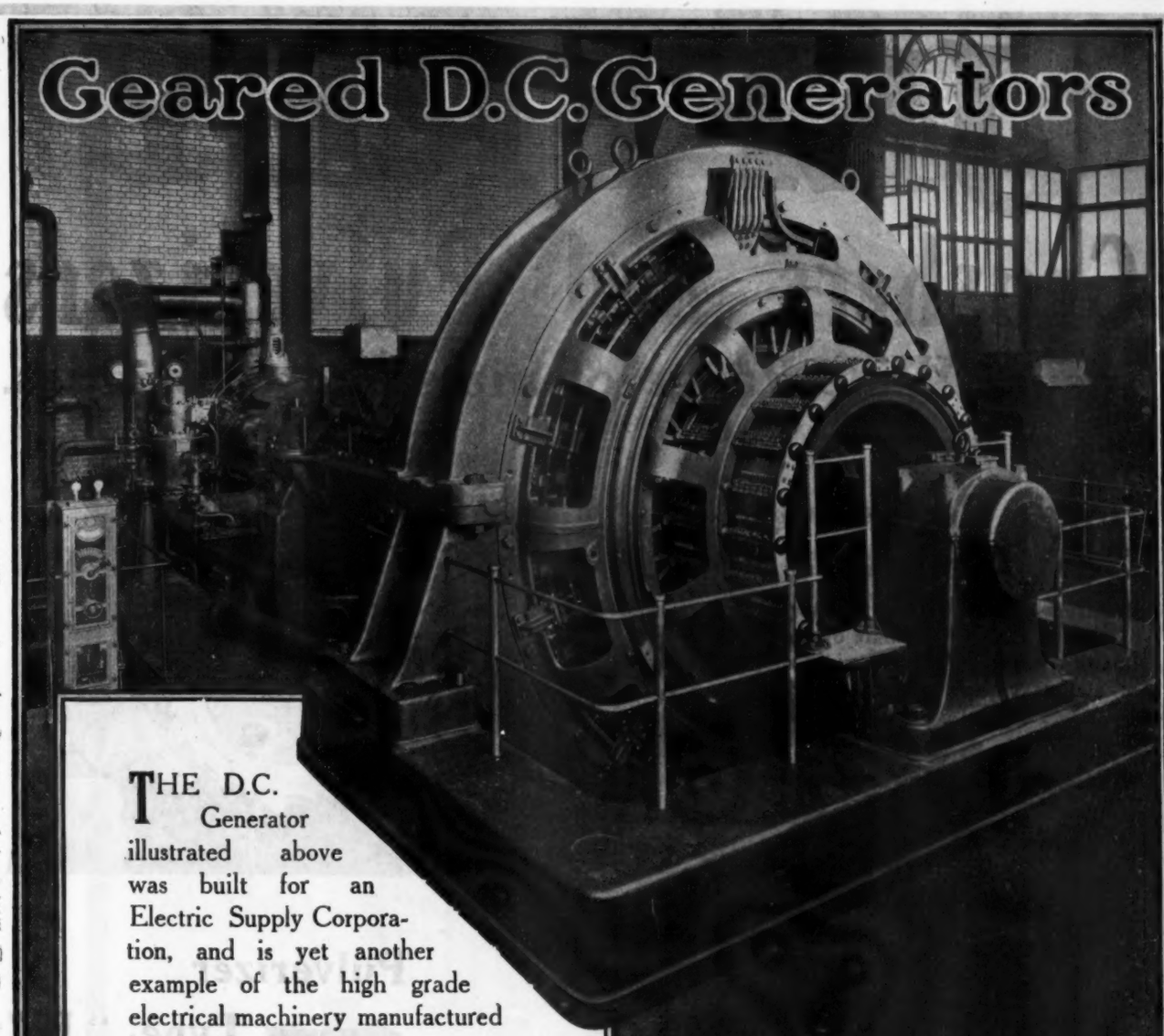
LOAD	20,000 *lbs.*
PRESSURE ON PADS	400 *lbs. per sq. in.*
SPEED	460 *R.P.M.*
CO-EFFICIENT OF FRICTION	·0015

9768

BROOM & WADE, LTD.
:: HIGH WYCOMBE. ::

WE SPECIALISE IN THE "MICHELL" AND HAVE GREATER EXPERIENCE IN MANUFACTURING THESE BEARINGS THAN ANY OTHER FIRM IN THE WORLD.

Geared D.C. Generators



THE D.C. Generator illustrated above was built for an Electric Supply Corporation, and is yet another example of the high grade electrical machinery manufactured by the Company.

Enquiries are invited for all classes and sizes of machines, from the smallest industrial motors to the largest Turbo-Generator Sets.

The ENGLISH ELECTRIC Company Limited.

WORKS:
BRADFORD, COVENTRY, PRESTON, RUGBY & STAFFORD.

HEAD OFFICE:
Queen's House, Kingsway, London, W.C. 2.
TELEPHONE: - - - - - - - - - HOLBORN 830.

3,000 K.W. 300 R.P.M. Geared D.C. Turbo-Generator

9514

JEFFREY

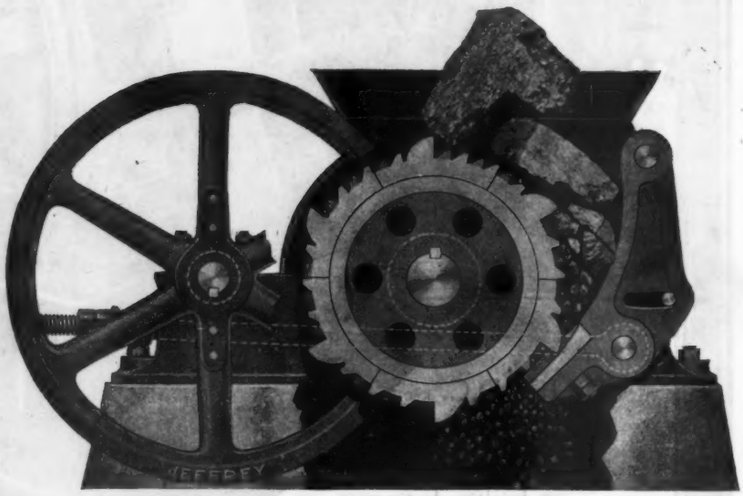
Crushers and Pulverizers

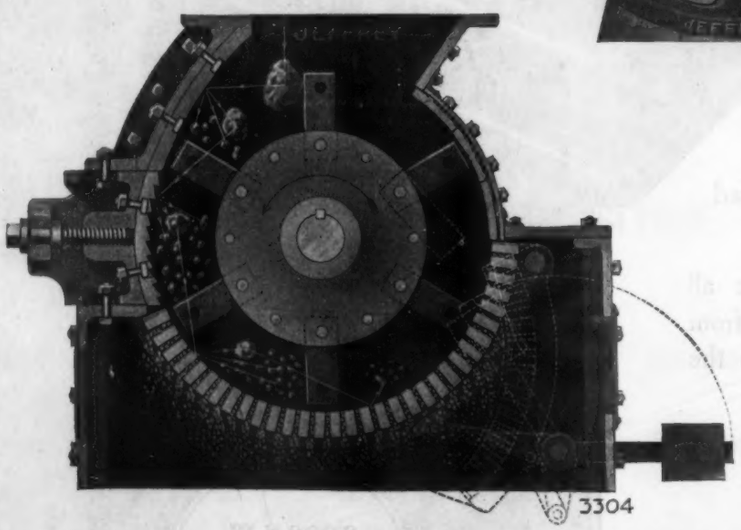
Insure Wide Range of Sizes and Capacities.

Single Roll Coal Crusher.

Reduces Run-of-Mine or Lump Coal to stoker sizes in a single operation. Readily adjustable to a wide range of sizings without change of equipment. Four sizes with capacities from 20 to 300 tons per hour.

Write for Catalogue No. 141.





Pulverizer Type "B."

One of several types of Jeffrey Swing Hammer Pulverizers for reducing Coal, Limestone, Marl, Gypsum, Phosphate Rock, Bones, Oyster Shells, Garbage, Tankage, etc.

Write for Catalogue No. 147A.

THE JEFFREY MANUFACTURING CO.

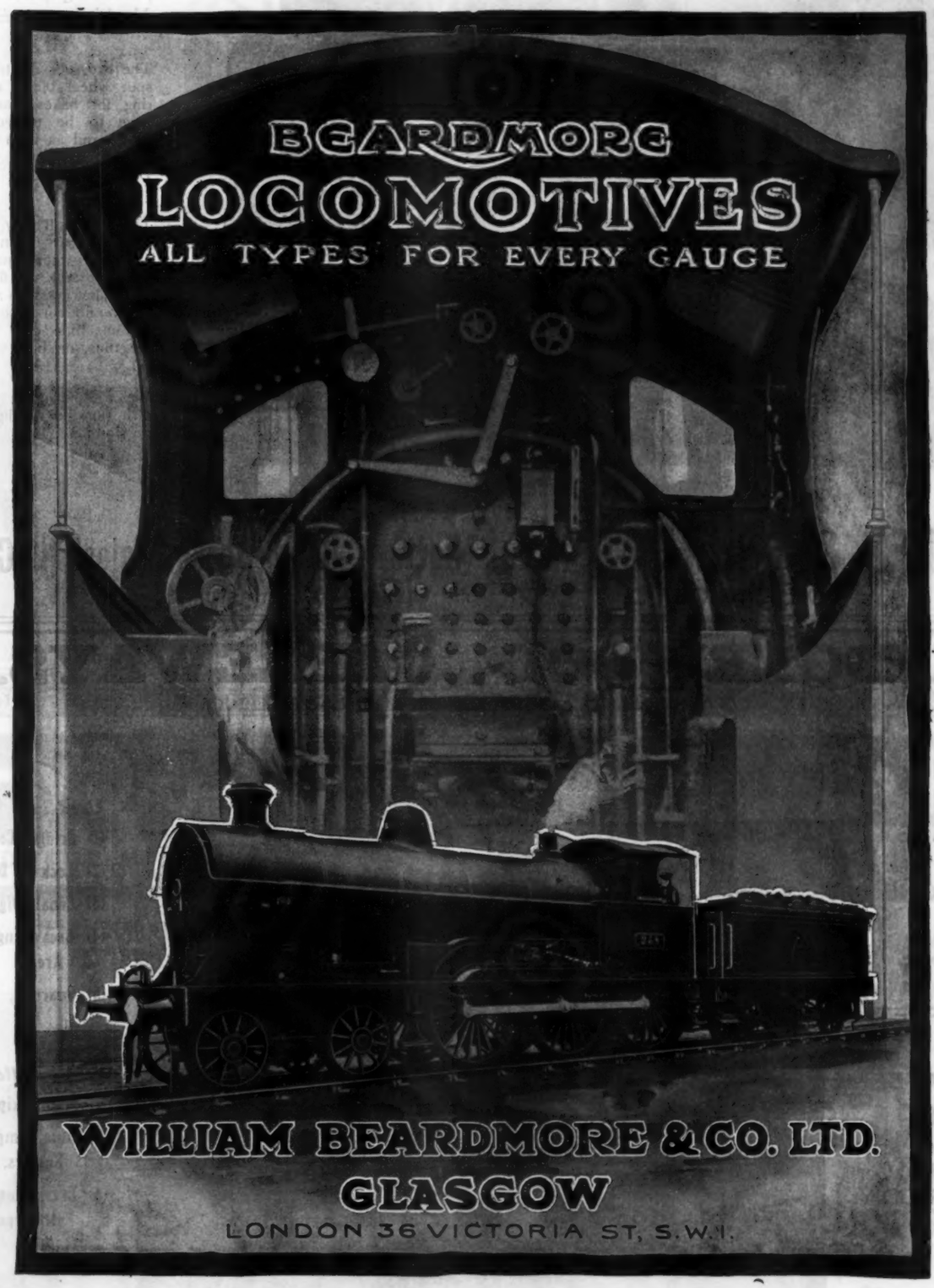
Represented in Great Britain by

HUGH WOOD & CO., LTD.,

65, FENCHURCH STREET, LONDON, E.C. 3.

Telegrams: "HUWOD, FEN., LONDON." Telephone: AVENUE 1545. 9430

Head Office: NEWCASTLE-ON-TYNE. And at MANCHESTER and CARDIFF.


BEARDMORE
LOCOMOTIVES
ALL TYPES FOR EVERY GAUGE
WILLIAM BEARDMORE & CO. LTD.
GLASGOW
LONDON 36 VICTORIA ST, S.W.1.

JEFFREY

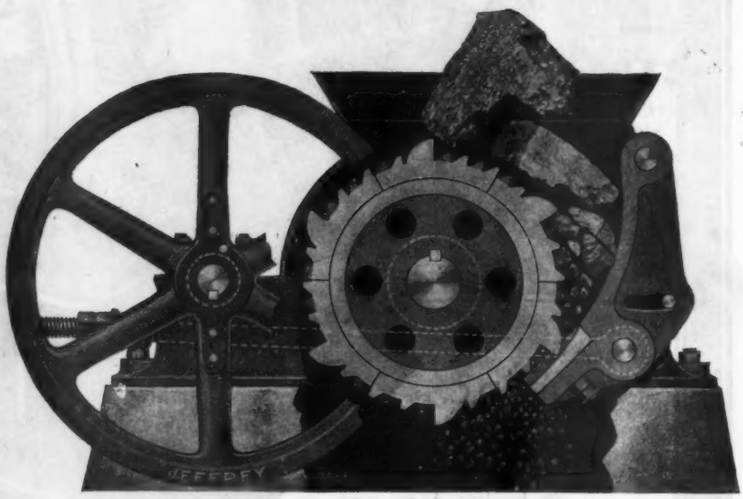
Crushers and Pulverizers

Insure Wide Range of Sizes and Capacities.

Single Roll Coal Crusher.

Reduces Run-of-Mine or Lump Coal to stoker sizes in a single operation. Readily adjustable to a wide range of sizings without change of equipment. Four sizes with capacities from 20 to 300 tons per hour.

Write for Catalogue No. 141.



Pulverizer Type "B."

One of several types of Jeffrey Swing Hammer Pulverizers for reducing Coal, Limestone, Marl, Gypsum, Phosphate Rock, Bones, Oyster Shells, Garbage, Tankage, etc.

Write for Catalogue No. 147A.

THE JEFFREY MANUFACTURING CO.

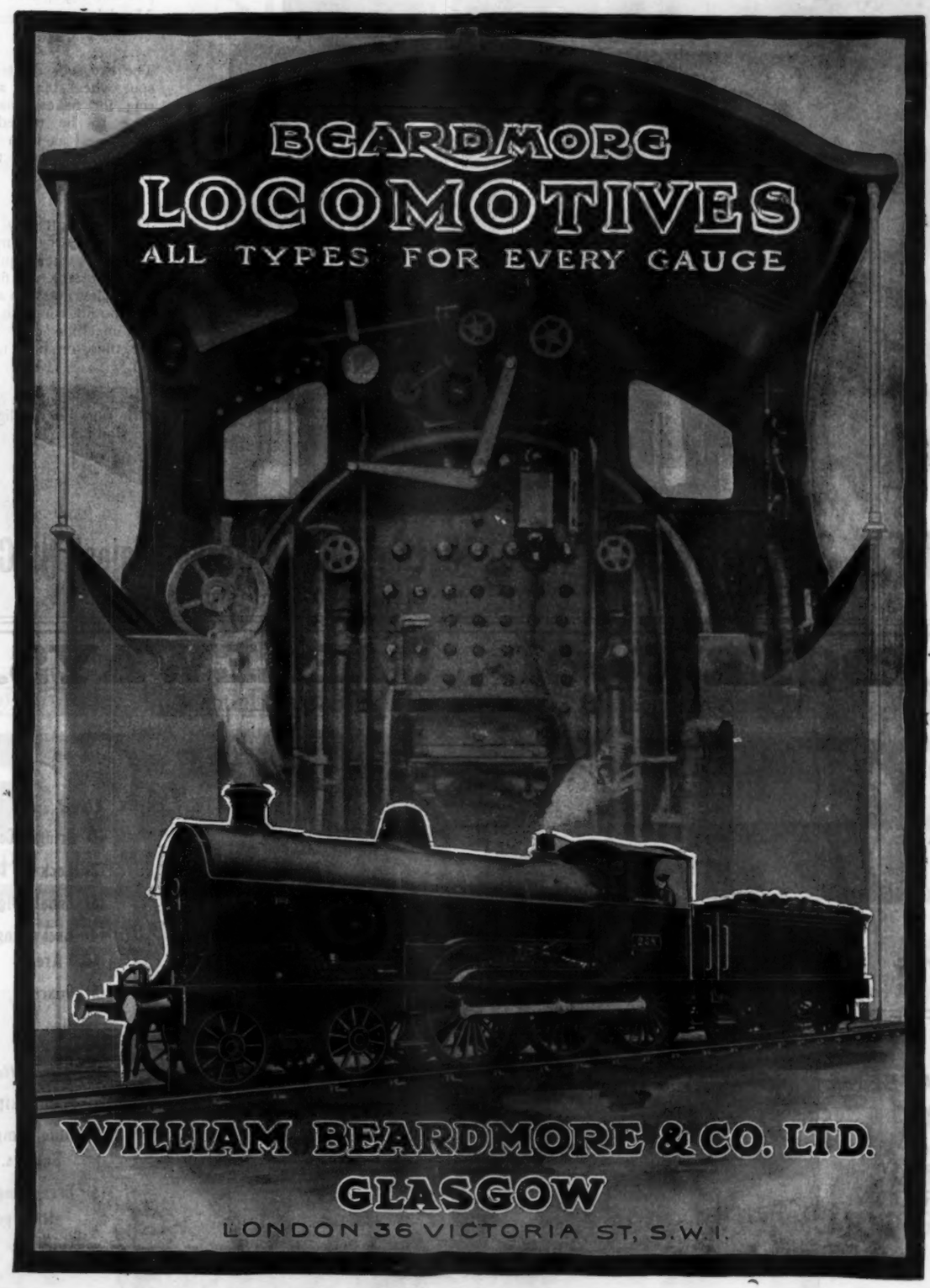
Represented in Great Britain by

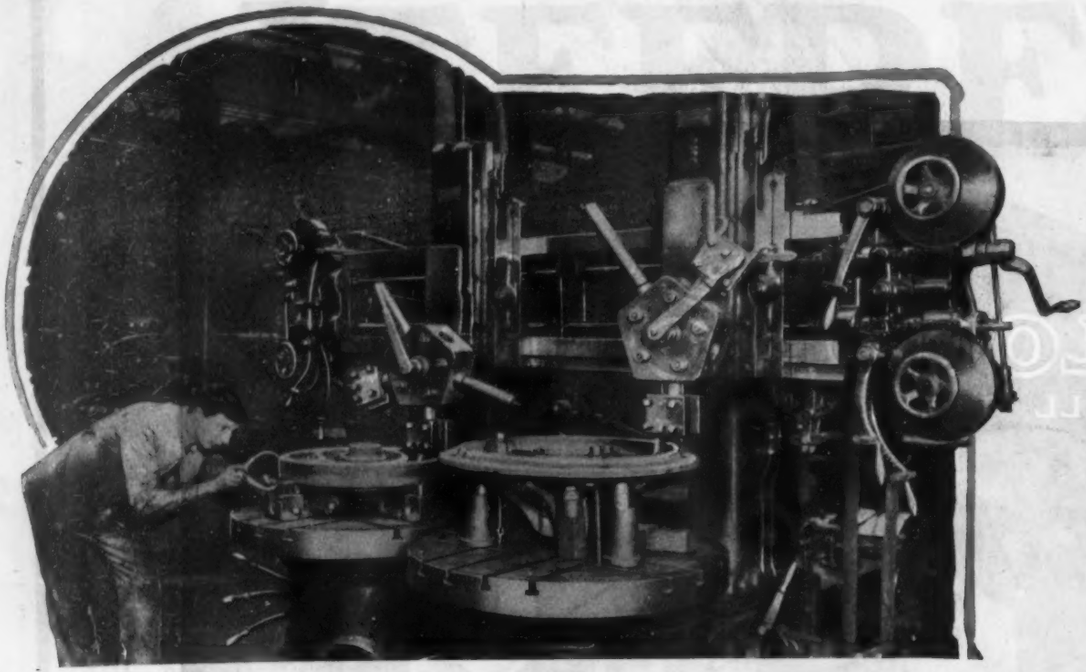
HUGH WOOD & CO., LTD.,

65, FENCHURCH STREET, LONDON, E.C. 3.

Telegrams: "HUWOD, FEN., LONDON." Telephone: AVENUE 1545. 9430

Head Office: NEWCASTLE-ON-TYNE. And at MANCHESTER and CARDIFF.


BEARDMORE
LOCOMOTIVES
ALL TYPES FOR EVERY GAUGE
WILLIAM BEARDMORE & CO. LTD.
GLASGOW
LONDON 36 VICTORIA ST, S.W.1.



THE W & B DUPLEX
producing parts for Baking Machinery.

The two jobs illustrated are a big spur wheel blank and a bearing ring for bakery machines. They have to be turned, bored and faced, and as both were urgently wanted, they came to the W & B Duplex.

The W & B way is the natural solution to many production problems where quick output is as important as fine limits. It means low costs on a wide range of work, and continuous production; the machine can be cutting all the time, on both tables.

We recommend a study of your own work in the light of W & B possibilities.

WEBSTER & BENNETT, LTD., Northey Road Works, Foleshill, Coventry.
LONDON OFFICE: 32, Victoria Street, Westminster, S.W.1.

9008

LIDGERWOOD CABLEWAYS.
STATIONARY, RADIAL OR TRAVELLING.

LOADS UP TO 20 TONS.

SPANS UP TO 2000 FEET.

OPERATED BY STEAM OR ELECTRICITY.

Used in—
(1) Bridge Construction.
(2) Lock & Dam Work.
(3) Canal Digging.
(4) Excavating over large Areas.
(5) Quarries, &c.

Will handle—
(1) Plain Skips.
(2) Auto-Dumping Buckets.
(3) Excavating Grabs of all Types.

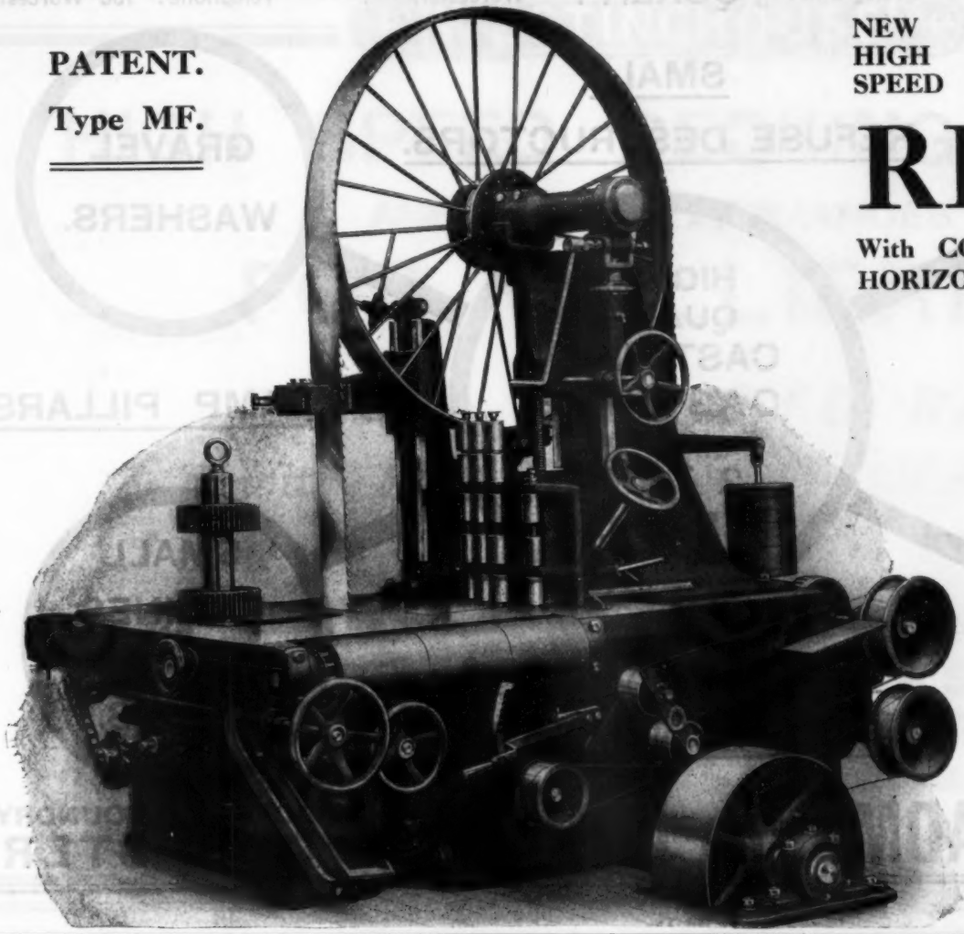
Illustration shows a LIDGERWOOD STATIONARY CABLEWAY, steam operated, 600 ft. span, 5 tons load, used for the entire construction of a five-arch reinforced Concrete Bridge. We also manufacture Hoists, Derricks, Pile-Drivers, &c.

9008

European Agents - - - - LIDGERWOOD LTD., Friars House, New Broad St., LONDON, E.C. 2.
Contractors for British Isles - - R. WHITE & SONS, Engineers, WIDNES, LANCS.

PATENT.

Type MF.



NEW HIGH SPEED

BAND RE-SAW

With COMBINED VERTICAL and HORIZONTAL ROLLER FEED.

A Machine of very large capacity. Will **Re-saw Deals and Battens at 200-ft. per minute.** Capable of handling the **widest flitches,** in addition to **18-in. square and round logs.**

EARLY DELIVERY.

Write for Leaflet "E 9."

785

THOMAS

ROBINSON

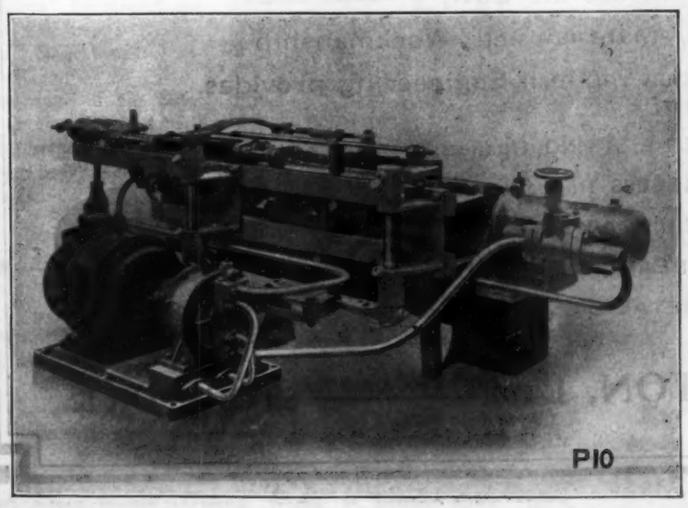
& SON, Ltd., ROCHDALE, Eng.

London Office—79, Queen Victoria St. E.C. 4

HYDRAULIC Variable Stroke PUMPS

PATENT HELE-SHAW SYSTEM and Rotary MOTORS

HELE-SHAW-MARTINEAU STEERING GEAR FITTED TO H.M. WAR VESSELS.



Transmission of Power by Oil Pressure up to

2,500 LBS. PER SQ. INCH

HYDRAULIC GEARS LTD.

Contractors to H.M. ADMIRALTY and WAR OFFICE

BEAVOR LANE, HAMMERSMITH, LONDON, W. 6.

786

Telephone: HAMMERSMITH 1933 & 1934

Telegrams: "HYGEARLIM, PHONE" LONDON

Directors:

S. GLUCKSTEIN · G.W. BOOTH · G.W. OATLEY · H.H. MACTAGGART · W.G. RIDDELL, O.B.E.

Established 1814. Telegrams: "QUALITY" Worcester. Telephone: 160 Worcester.

SMALL
REFUSE DESTRUCTORS.

SAND WASHERS.

GRAVEL WASHERS.

HIGHEST QUALITY CAST IRON CASTINGS UP TO 2 TONS EACH.

MANHOLES.

LAMP PILLARS.

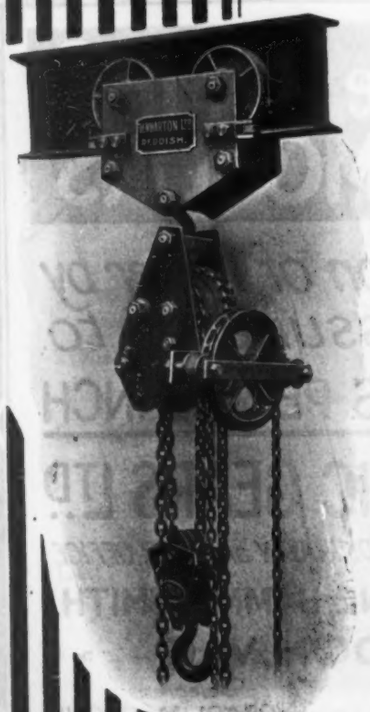
SAND DRYERS.

SMALL ENGINES AND PUMPS.

ROAD, WARNING & DIRECTION POSTS.

7721

HARDY & PADMORE, LIMITED, WORCESTER FOUNDRY, WORCESTER.



You Take a Big Risk;
to MEN and MATERIALS.

You waste Time and Money;
buying CHEAP BLOCKS and TROLLEYS.

Although our Prices are Low,——
Our Designs, Material and Workmanship
are the best that modern Engineering provides.

ROLLER BEARING Runners.
FLANGELESS Runners.
ROLLER BRACKET Side plates.
BALL BEARING Bottom Hook.
GUN METAL Bushed Bearings.

9790

ON THIS WE STAND
A DEAL
— OR FALL. —

H. WHARTON, LTD. —— STOCKPORT.

WESTINGHOUSE

HIGH SPEED DECKING PLANT

AND SAFETY APPLIANCES

FOR COLLIERIES

POWER OPERATED RAMS with ELECTRIC INTERLOCKING

Manufactured at their Works in London and Chippenham, by:

THE WESTINGHOUSE BRAKE & SAXBY SIGNAL CO., LTD.

82, York Road, KING'S CROSS, LONDON, N. 1.

Agents: Messrs. TAYLOR & SHAW (Engineers), 121, Devonshire Street, Sheffield. 643

Telephone No.—CENTRAL 5176

WATER SUPPLIES.

ARTESIAN BORED TUBE WELLS.

C. ISLER'S improved system of raising large or small quantities of WATER FROM ANY DEPTH by IMPROVED AIR LIFT PUMPS, TURBINE AND DEEP WELL PUMPS, or any other kind of Pump.

We are makers of Improved Combined Rotary and Percussion Drilling Machines for Water, Oil, etc., to bore to any depth and size.

The "Cores" illustrated are obtained by means of our "Rotary" Shot Drill.

The advantage of the Shot Drill over the diamond drill and other rotary systems is that larger bore-holes can be drilled at much less risk and cost.

Perpendicular bore-holes are ensured.

Bore-holes 3 inches to 48 inches diameter.

We are the pioneers in this country of the Air Lift system of raising water.

Geological opinions furnished.

Reports and estimates furnished for any kind of Drilling or Pumping Plants or Artesian Bored Tube Wells for Water Supplies.

Deep Well Pumps.

Turbine Pumps.

Steam, Electric, Oil and Gas Plants.

C. ISLER & CO., LTD.,

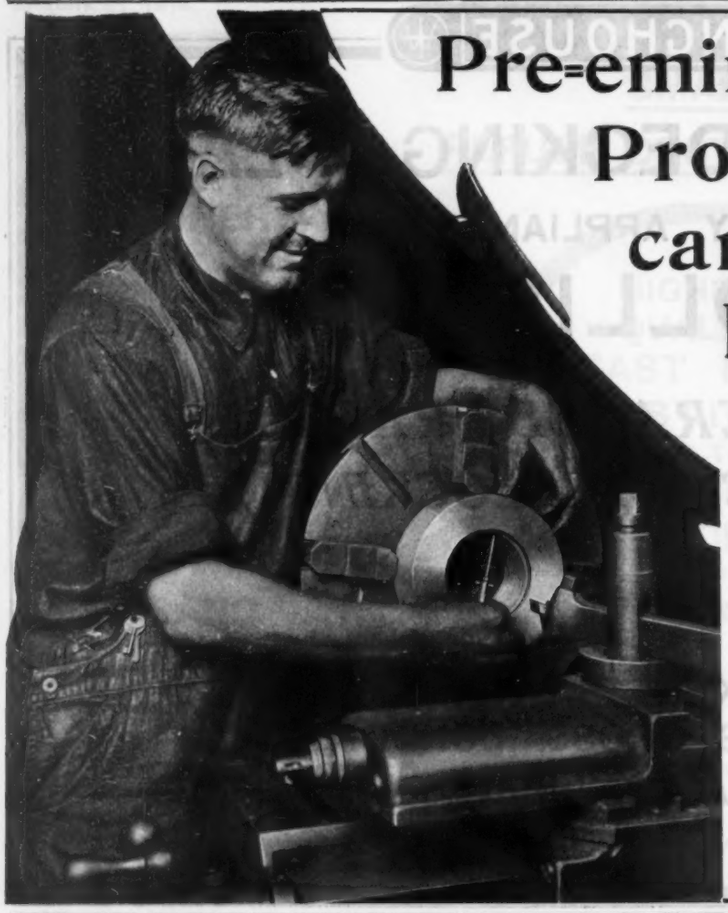
Artesian Well and Consulting Engineers,

Artesian Works, Bear Lane, SOUTHWARK STREET, LONDON, S.E. 1.

Birmingham Branch:—Artesian Works, 58, Summer Row. Leeds Branch:—210, Wellington Street. And at Liverpool. 9845

CONTRACTORS TO H.M. WAR DEPT., ADMIRALTY, CROWN AGENTS, INDIA OFFICE, &c.

Telegrams - "Isler, London."
Telephone - Hop 4400 (3 lines).



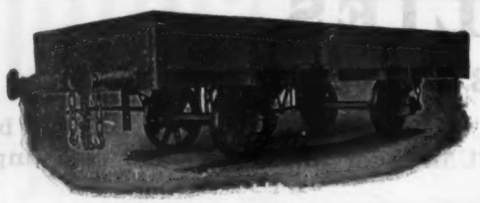
Pre-eminent for Accurate Production, & it can be tested in our Demonstrating Showrooms.

645

NO one type of Engine Lathe is adapted to all classes of lathe work. Certain classes of work can be most economically handled on a certain type of lathe, consequently "American" Lathes are built with four different types of headstocks, each one of which is suited to a certain class of work. Before buying a lathe, the advantages and adaptability of each type to your work should be carefully investigated and considered.

Have you had the Efficiency Bulletin? If not, write now.

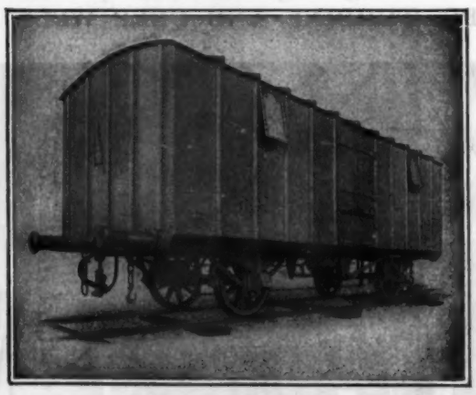
BUCK & HICKMAN
LIMITED,
2–6, WHITECHAPEL RD., LONDON, E.1



HEAD, WRIGHTSON & CO., LD.

THORNABY-ON-TEES and STOCKTON-ON-TEES.

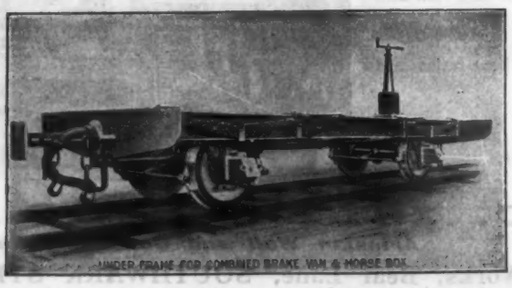
CONSTRUCTIONAL ENGINEERS,
IRONFOUNDERS, &c. &c.



WAGON BUILDERS.

CASTINGS OF EVERY DESCRIPTION

WAGON FORGINGS
and
ACCESSORIES.

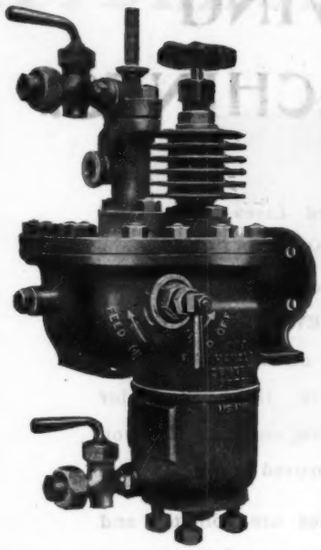


2493

CONTRACTORS TO BRITISH, COLONIAL AND FOREIGN RAILWAYS.

INSTANTANEOUS REGULATION

is the outcome of adopting



AS FITTED BY THE BRITISH ADMIRALTY AND UNITED STATES NAVY.

ASTER
—ANTHONY
AUTOMATIC
Patent Boiler Feed
REGULATORS

These thoroughly proved and remarkably efficient regulators can be depended upon, at all times, to maintain with certainty the correct water level.
They reduce your fuel costs. Avoid priming and low water, with its ever-attendant dangers. Save labour and economise maintenance costs.

Practical Proof of Aster Claims gladly forwarded on request.

(Steam Dept.).

ASTER ENGINEERING CO. (1913), LTD.
WEMBLEY, :: :: :: MIDDLESEX.
Telephone: WEMBLEY 22 & 23.

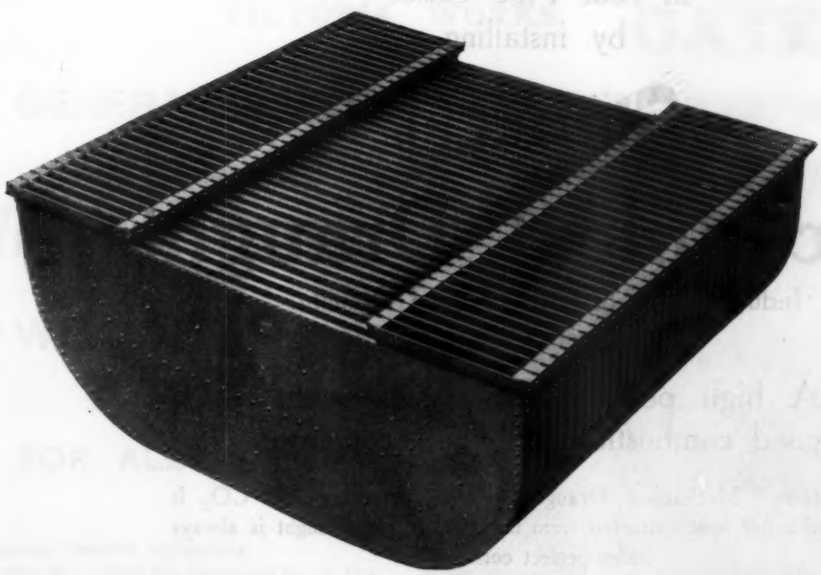
9792

UNDERFEED STOKER CO., LTD.,

COMBUSTION ENGINEERS,

Coventry House,
South Place,
London, E.C. 2.

"USCO" AIR HEATER
For recovering the heat of waste gases.



Makers of . . .

MECHANICAL STOKERS.

AUTOMATIC
ASH CONVEYORS.

WATER HEATERS.

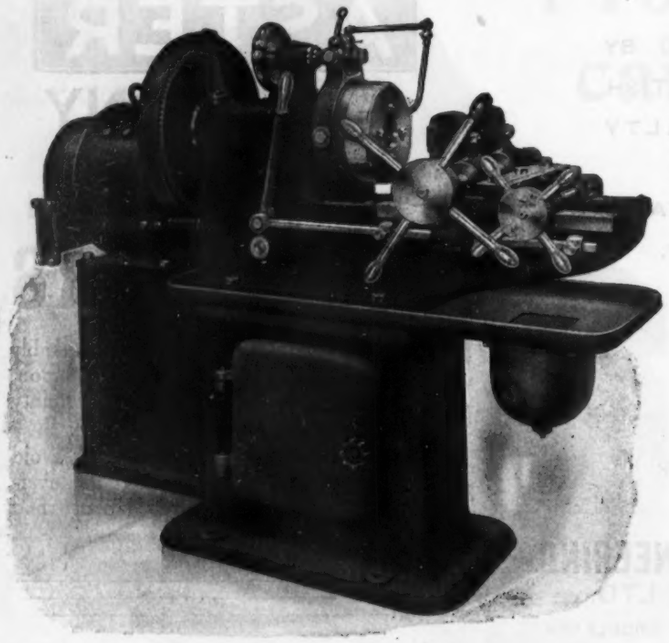
PULVERISED
FUEL EQUIPMENT.

&c.

9793

A series of elements built up to any size.
High rates of heat transference.
Maximum heating surface in a given space.
Minimum resistance to flow of air and gas.

SCREWING MACHINES.



½ MOTOR DRIVEN BOLT SCREWING MACHINE WITH AUTOMATIC DIE HEAD.

Our Standard Lines are TUBE SCREWING MACHINES in various sizes up to 18 in. diameter, BOLT SCREWING MACHINES up to 4 in. diameter. We have specialised in these lines for almost 60 years, and can offer you machines of proved practical value.

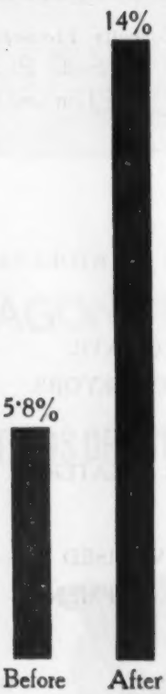
Your enquiries are solicited and will receive our careful attention.

514

MAIDEN & CO., LTD.,

HYDE, Near MANCHESTER.

Telephone—29 HYDE. Tel. Add.—MAIDEN HYDE



"Sirocco" Induced Draught Plant was installed.

Average CO_2 Results in 24 hours obtained at a Power Station.

Increase the CO_2

in your Flue Gases
by installing

TRADE SIROCCO MARK

Mechanical Draught

Induced Draught. Forced Draught.
Balanced Draught.

A high percentage of CO_2 means good combustion and fuel economy.

With "Sirocco" Mechanical Draught a high percentage of CO_2 is secured and a full heat extracted from the Fuel. The draught is always under perfect control.

8540

DAVIDSON & CO., LIMITED,

SIROCCO Engineering Works, BELFAST.

HYDRAULIC MACHINERY OF EVERY DESCRIPTION & FOR EVERY PURPOSE.

PART OF AN ORDER FOR
THREE-CYLINDER TURNOVER HYDRAULIC CAPSTANS,
DESIGNED TO GIVE A PULL OF ONE TON ON ROPE ROUND BARREL AND TO HAUL WAGGONS AT 120 FT. PER MIN.
HYDRAULIC WORKING PRESSURE, 800 LBS. PER SQUARE INCH. 9971

GLENFIELD & KENNEDY LTD.,

KILMARNOCK
SCOTLAND.

TELEGRAMS. "GLENFIELD" KILMARNOCK.

CLARKE, CHAPMAN & CO., LTD.,

VICTORIA WORKS, GATESHEAD.

GENERAL & ELECTRICAL ENGINEERS & BOILERMAKERS.

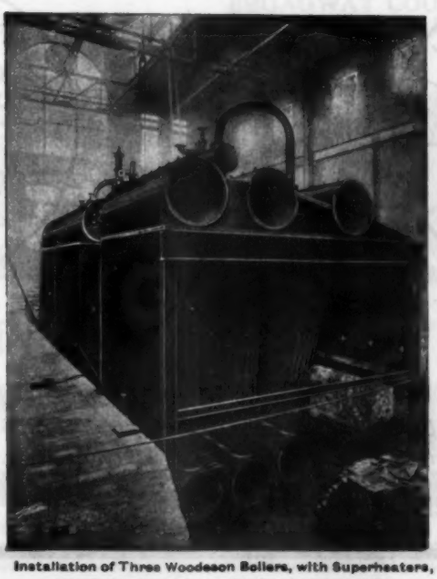
WATERTUBE BOILERS.

"WOODESON'S"
PATENTS

FOR ALL DUTIES.

Telegrams: CYCLOPS, GATESHEAD.
Telephone Nos.: 1070 & 1073 Central, and No. 137, City.
Trunk Calls: 2196, Central.

CODES:—
A. B. C. 4th & 5th Editions, A. 1.,
Engineering, 1st & 2nd Editions,
Lieber's Broomhalls, Moreing & Neil's, Watkins,
Western Union, and Private.



Installation of Three Woodeson Boilers, with Superheaters, supplied to large Power Station in Lancashire.

SPECIAL FEATURES:

Maximum ease of access for examination and cleaning.

All heating tubes straight and of equal length.

Maximum steam release areas.

Good Combustion and Circulation.

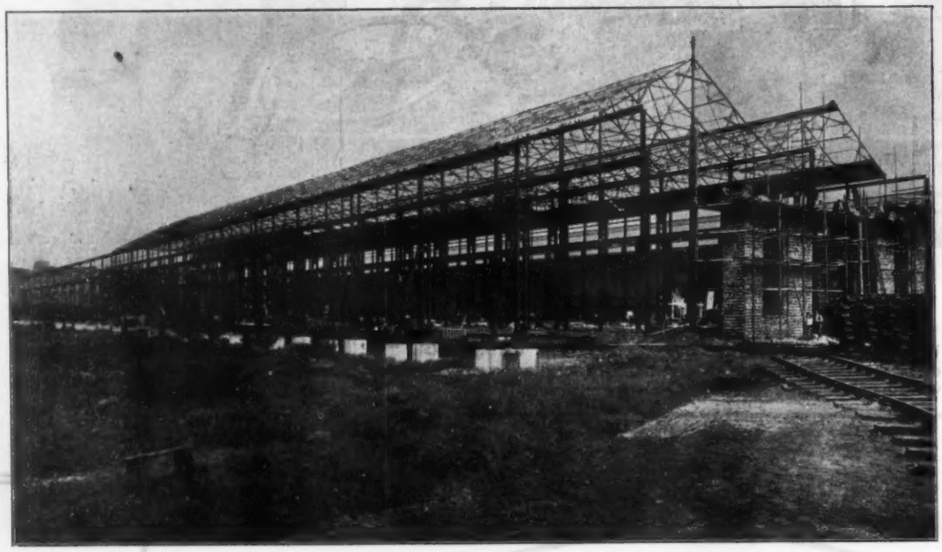
Ease in erection.

Large steam space. 666

LONDON OFFICE:
50, Fenchurch Street, E.C.
Telegrams—"Cyclops, Fen, London."

THE STEEL CONSTRUCTION CO., LTD.

CRAIGHALL IRONWORKS, GLASGOW.



London Offices—

118, CANNON STREET, E.C.4.

Designers, Makers and Erectors of Steel Framed Buildings, Riveted Tanks, Pipes, Hoppers and General Constructional Steelwork for Home and Export.

5525

QUANTITY PRODUCTION OF QUALITY PRODUCTS

COPPER AND BRASS SHEETS, WIRE, TUBES, DROP FORGINGS, CRANKSHAFTS, CONN. RODS, VALVES, WRENCHES, SPANNERS, BOLTS, NUTS, RIVETS, CUPS, BALLS, FILES, SPRINGS, CHEMICALS, ABRASIVES, Etc., Etc.

FURNACE AND FUEL TO SUIT CONDITIONS

COAL, COKE, OIL, GAS, ELECTRICITY.

W.S. ROCKWELL CO. INDUSTRIAL ESTABLISHED 1888 FURNACES 50 CHURCH ST. NEW YORK

INDUSTRIAL GIBBONS BROS. LTD. DUDLEY FURNACES

HEATING, ANNEALING, HEAT TREATING, CAR AND BALL TYPE, CONTINUOUS, AUTOMATIC, MUFFLE, ROTARY FURNACES.

GIBBONS BROS. LTD. beg to announce that they have entered into arrangements with the W. S. ROCKWELL CO., NEW YORK, U.S.A., as their representatives for the British Empire, excluding Canada, for the manufacture of their Industrial Heating Furnaces.

CORRESPONDENCE INVITED. 8526

GIBBONS BROS. LTD., DIBDALE WORKS, DUDLEY, WORCS.

LONDON. MANCHESTER.
CARDIFF. MELBOURNE.

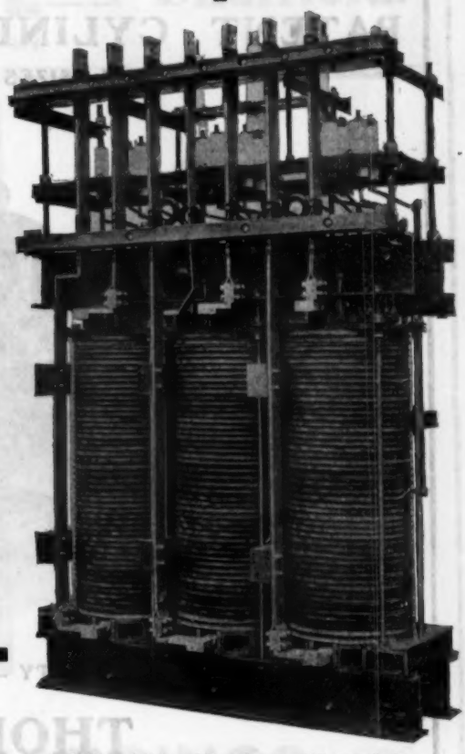
TRANSFORMERS

FOR
POWER AND LIGHTING.
ROTARY CONVERTERS.
ELECTRIC FURNACES AND WELDERS.
UNDERGROUND COLLIERY WORK.
ELECTRO-CHEMICAL MANUFACTURES.
HIGH-VOLTAGE TRANSMISSION.

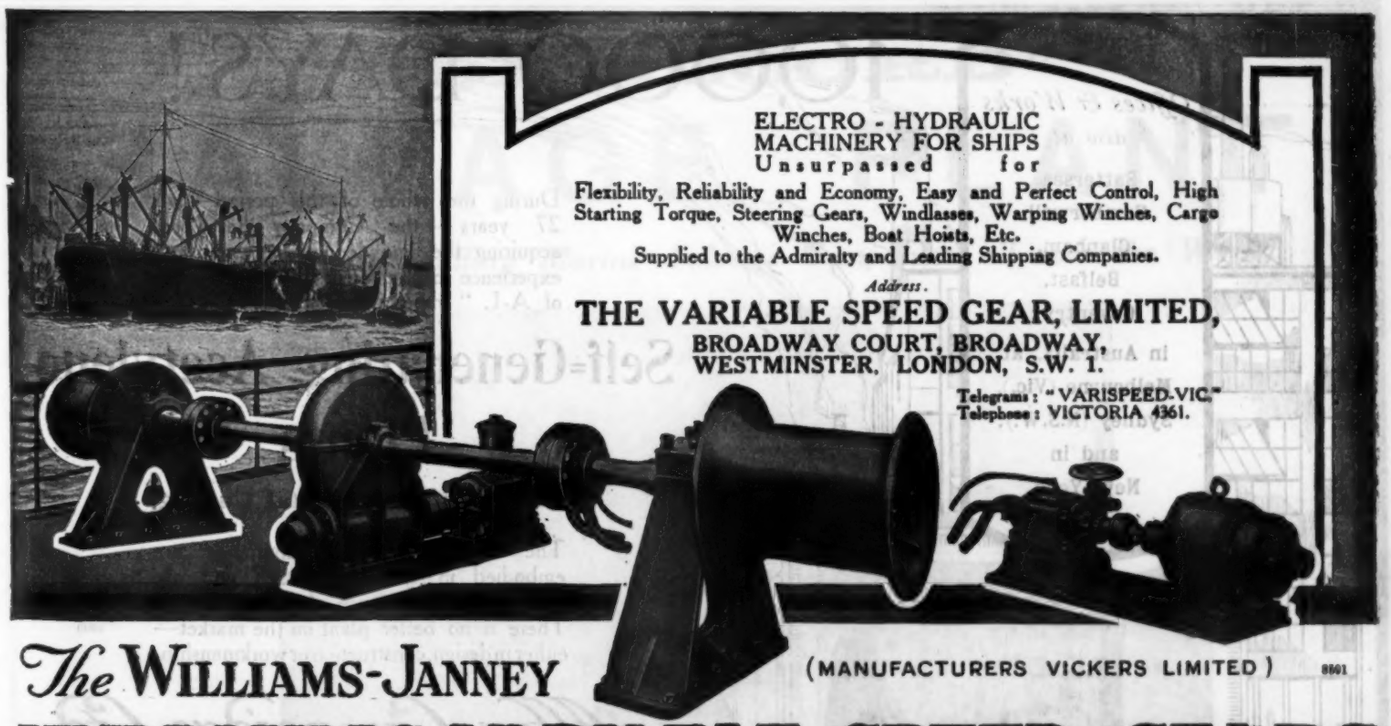
We specialise in the production of Transformers specially designed and manufactured to withstand heavy service; and suitable for indoor or outdoor service.

Our twenty-seven years of experience in building Transformers is at your service.

THE
BRUSH
ELECTRICAL ENGINEERING Co., LTD.
FALCON WORKS, LOUGHBOROUGH.



2,100 kVA, 3/6-phase, 50-period, 10,500/380-volt, O.I.S.C. Transformer (2026).



ELECTRO-HYDRAULIC MACHINERY FOR SHIPS
Unsurpassed for
Flexibility, Reliability and Economy, Easy and Perfect Control, High Starting Torque, Steering Gears, Windlasses, Warping Winches, Cargo Winches, Boat Hoists, Etc.
Supplied to the Admiralty and Leading Shipping Companies.

Address.
THE VARIABLE SPEED GEAR, LIMITED,
BROADWAY COURT, BROADWAY,
WESTMINSTER, LONDON, S.W. 1.
Telegrams: "VARISPEED-VIC."
Telephone: VICTORIA 4361.

The WILLIAMS-JANNEY (MANUFACTURERS VICKERS LIMITED)
HYDRAULIC VARIABLE SPEED GEARS

HUDSON

PATENT CYLINDRICAL AND WATER-TUBE BOILER.

ALL SIZES SUPPLIED WITH OR WITHOUT SUPERHEATERS.

ESTIMATES AND SPECIFICATIONS WILL BE SENT ON APPLICATION.

ACCESSIBILITY — DURABILITY — LARGE THERMAL STORAGE — HIGH EFFICIENCY AND ECONOMY.

8674

THOMAS HUDSON, LIMITED,

SHEEPFORD BOILER WORKS - - - - - COATBRIDGE.

10,000 DAYS!

Offices & Works also at

Battersea, Camberwell, Clapham, Belfast, Coventry; in Australia, at Melbourne (Vic.), Sydney (N.S.W.); and in New York.

A-L "IMPERIAL" PORTABLE PLANT (Class 9).

During the whole of this period—over 27 years — the Company has been acquiring the knowledge that only long experience can give in the construction of A-L "Imperial"

Self-Generating Acetylene Plants

For Welding and Metal Cutting.

The results of that experience are embodied in the plant itself and are therefore at the service of our customers. There is no better plant on the market—either in design, construction or workmanship.

9990

Allen-Liversidge Ltd.

HEAD OFFICE:

106, Victoria Street, Westminster, S.W. 1.

Telephone: VICTORIA 4155 (Ptc. Bch. Exchange).

Telegrams: "ACETERATOR, SOWEST, LONDON."

CAMMELL LAIRD & CO., LTD., Sheffield.

LONDON OFFICE: , Central Buildings, Westminster, S.W.

DOUBLE THROW CRANK SHAFT. WEIGHT 21 TONS.

TOOL STEEL.
HIGH-SPEED STEEL.
SPRING & MINING STEEL.
BILLETS, BLOOMS,
PITRAILS, GIRDERS.
SHOES & DIES.
MANGANESE STEEL
FILES & RASPS.

STEEL CASTINGS AND FORGINGS.

631

"BON-ACCORD"

SALVAGE PLANT

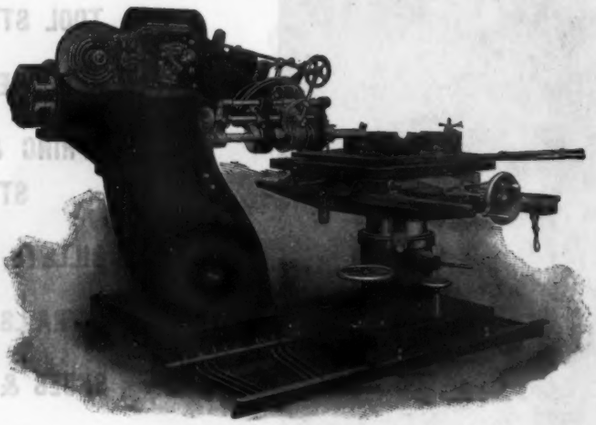
As supplied to the leading Marine Salvage Companies all over the World.

Norwegian S.S. "Alix," being floated with Drysdale Steam-Salvage Pumps. 2818

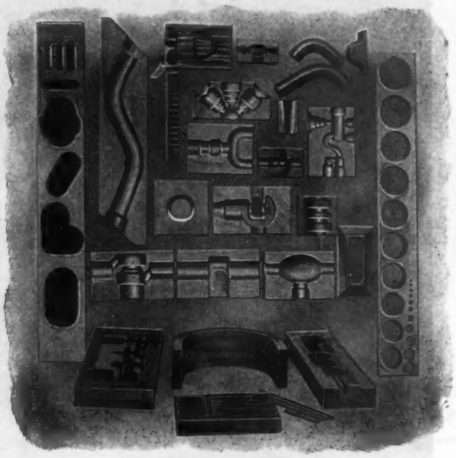
DRYSDALE & CO., Ltd., Yoker, GLASGOW, W., Scotland.

Wadkin Mechanical Woodworker

Will reduce your pattern costs.



The machine operating on a three-way valve core-box, showing self-contained motor drive.



505

A group of a few core-boxes, &c., which have been produced throughout on this machine.

Let us arrange a demonstration———The results will surprise you.

Wadkin & Co. Leicester

SPANNERS.

Single and Double-Ended. All sizes up to 2" supplied from stock.

***SPECIAL SPANNERS* made for following trades:—**

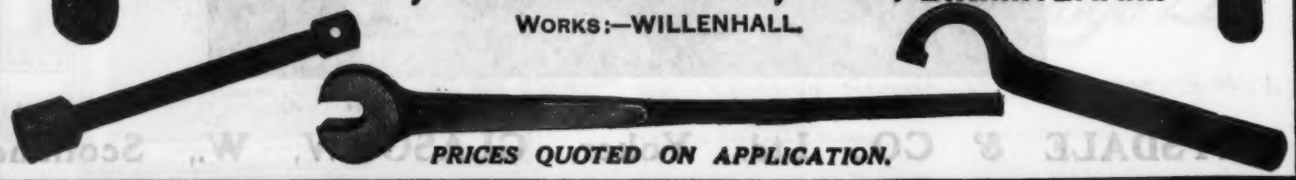
ENGINEERING
SHIPBUILDING
CONSTRUCTIONAL
BRIDGE BUILDINGS
MOTOR CARS AND LORRIES

AGRICULTURAL IMPLEMENTS
RAILWAY PERMANENT WAYS
MACHINE TOOLS
LOCOMOTIVES
WATER DEPARTMENTS

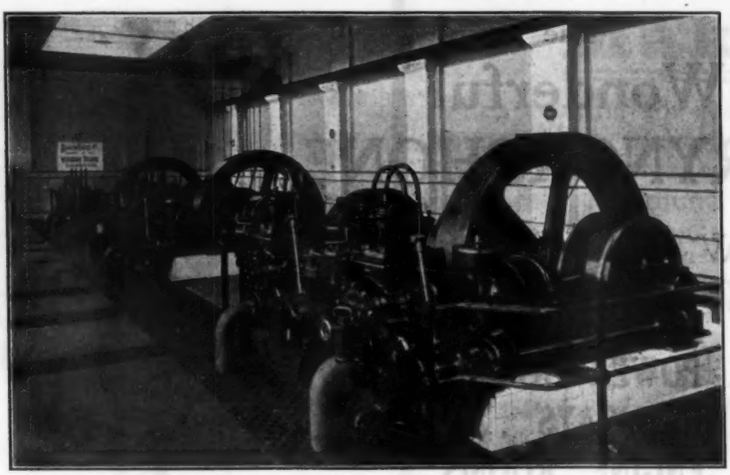
3075

ARMSTRONG, STEVENS & SON, LTD., WHITTALL ST., BIRMINGHAM.

WORKS:—WILLENHALL.



PRICES QUOTED ON APPLICATION.



Installation of three 160 B.HP. Suction Gas Engines working on Producer Gas, Direct Coupled to Electric Generators, at the Works of Messrs. Smith, Faire & Co., Leicester.

Crossley Gas Engines maintain all the features on which their high reputation has been built.

THE HIGHEST GRADE GAS ENGINES IN THE WORLD

CROSSLEY GAS ENGINES

Reliability. This has always been our main aim. The design is based upon the experience of over 50 years. The workmanship is superb; all parts are standardised and made to jigs, and fit together with exactitude. The utmost care is exercised in the choice of materials, only the best are used.

Economy. We have introduced the following features in the design of Crossley Engines:—Symmetrical combustion chamber, vertical valves, inlet valves in separate cage, variable admission governing, forced and ring lubrication. In consequence they are highly economical in fuel and lubricating oil consumption, and require little attention.

Simplicity. All the recent improvements, while adding to the reliability of Crossley Engines, have also increased the simplicity both in construction and operation. Crossley Engines do not require highly-skilled attention to keep them in good working order.

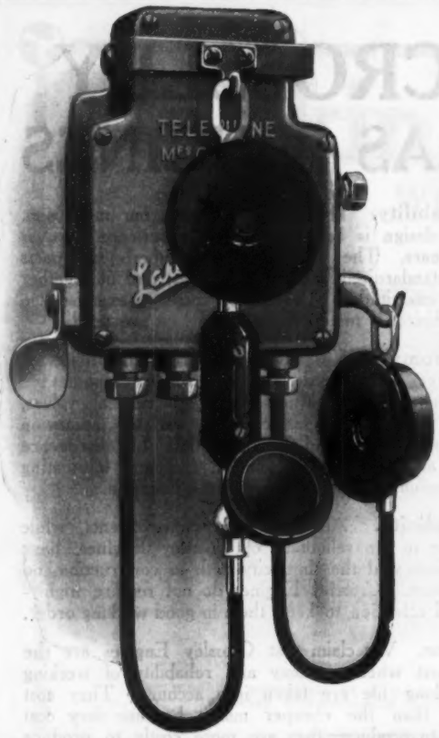
Value. We claim that Crossley Engines are the cheapest when economy and reliability of working and long life are taken into account. They cost more than the cheaper makes because they cost more to produce—they are more costly to produce because they include more, are better designed and better constructed.

692

CROSSLEY BROTHERS, LTD., OPENSHAW, MANCHESTER.

London Office: 139-141, Queen Victoria Street, E.C. 4.

PARTINGTON STEEL & IRON COMPANY LTD



The
Wonderful
LARYNGAPHONE

HOW to TELEPHONE
IN THE MIDST of NOISE

POWER HOUSES
RAILWAYS . . .
ENGINE ROOMS
FOUNDRIES . . .
COTTON MILLS
DIVER'S WORK
BOILER SHOPS

THE
LARYNGAPHONE HAND SET
Can be fitted to any existing Telephone of any make.

ENGINEERS EVERYWHERE.

THE TELEPHONE MANUFACTURING CO., Ltd.
HOLLINGSWORTH WORKS, WEST DULWICH, LONDON, S.E. 21.
Telephone—SYDENHAM 2460-2461. 670 Telegrams—"BUBASTIS, DULCROX, LONDON."

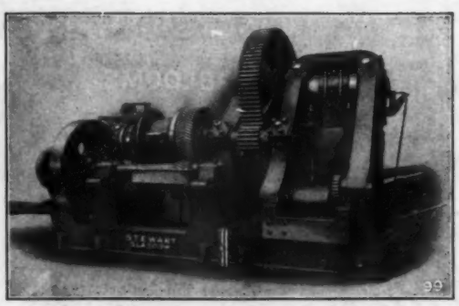
DUNCAN STEWART & CO., LTD.,
LONDON ROAD IRONWORKS,
GLASGOW.

Tel. Address—
"STEWART, GLASGOW."

ESTABLISHED
1864.

HYDRAULIC MACHINERY.

Steam Hydraulic Forging Presses,
Shaft Straightening Presses,
Troughing Presses,
Accumulators,
High Pressure Hydraulic Pumps,
Etc.



Electrically-Driven 12 in. by 8 in. Billet Shears.

STEEL WORKS PLANT.

Rolling Mills, all types and sizes,
Rolling Mill Engines,
Bloom, Slab, Billet and Plate Shears,
Hot Saws,
Steam Hammers,
Tube Drawbenches,
Etc.

6826

No. 245 JUNIOR "UNIVERSAL" CONTROL PANEL for use with motors ¼ HP. to 3 HP.

Making sure.

When looking for real efficiency and increased output from your machine tools, do not stop at getting the best machine and the best motor, but see the controller is "IGRANIC." It is the essential adjunct that ensures success.

"IGRANIC" UNIVERSAL AUTOMATIC Control Panels consist of an automatic starter, which can be operated by push button or master switch, fixed on the machine and a speed regulator which allows the motor to be run up to the pre-determined speed automatically. A hand operated main switch is also included for isolating the motor.

SAVES TIME,
PREVENTS ABUSES,
ABOLISHES BREAKDOWNS,
SPEEDS UP PRODUCTION.

Send us your enquiries.

No. 250 "UNIVERSAL" CONTROL PANEL comprises solenoid self starter, magnetic circuit breaker, speed-setting regulator, isolating main switch, door interlock.

IGRANIC
ELECTRIC CO., LTD.,

147, Queen Victoria St., LONDON.

Works: **ELSTOW ROAD, BEDFORD.**

BRANCHES:—

Glasgow: 50, Wellington Street. Bradford: 18, Woodview Ter., Manningham.
Manchester: 30, Cross Street. Cardiff: Western Mail Chambers.
Birmingham: 73, Exchange Buildings.

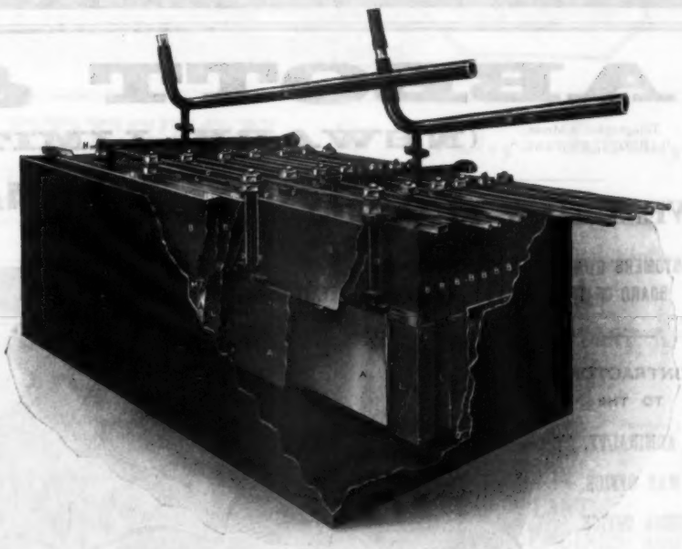
9094

KNOWLES
OXYGEN-HYDROGEN GENERATORS
HAVE STOOD THE TEST OF TIME.

PRODUCE PUREST GASES AT LOWEST COST.

REQUIRE LITTLE ATTENTION.

NORMAL OUTPUT CAN BE INSTANTLY INCREASED OR DECREASED 50% AND CELLS USED TO MAINTAIN A HIGH LOAD FACTOR.



ENSURE MINIMUM GAS AND LABOUR CHARGES IN WELDING AND CUTTING.

MAY WE GIVE YOU A DEMONSTRATION FREE OF CHARGE?

9044

FULL PARTICULARS FROM:

THE INTERNATIONAL ELECTROLYTIC PLANT CO., Ltd.,

NEW CRANE STREET, CHESTER.

R. White & Sons, Widnes, Lancs.
FOR **RAILS,** 9906
POINTS AND CROSSINGS.
AERIAL ROPEWAYS.

SCALING BOILERS
THERE IS NOTHING SO QUICK & EFFICIENT AS THE "Matos Kalo" PATENT SCALING TOOL
SEE MY ADVERT IN ISSUE OF JUNE 23.
FRANK GILMAN WILDERS DRIVE WARWICK ROAD BIRMINGHAM

The CLYDE STRUCTURAL IRON CO., Ltd.,
Clydeside Ironworks, Scotstoun, Glasgow.
MANUFACTURERS OF 9181
Iron & Steel Roofs, Buildings, Workshops, &c., &c.
LONDON OFFICE: 48, Cornhill, E.C.

TURNBULL'S SAFETY, STOP, CHECK, SLUICE & REDUCING VALVES
Send for Catalogue
ALEX. TURNBULL & Co. LTD. GLASGOW.

DIVIDING HEADS
PLAIN AND UNIVERSAL 9854
For MILLING MACHINES.
ROTARY TABLES FOR MILLING AND SLOTTING MACHINES.
THE WHEELER MNFG. CO. LTD.,
65E, Trench Crossing, Wellington, Salop.

ARC LAMP LOWERING GEAR
The London Electric Firm, Croydon.
SEND FOR LISTS. 9806

DANIELS GAS PLANTS
DANIELS GAS ENGINES
DANIELS HIGH-SPEED PUMPS
Complete Pumping Installations.
T. H. & J. DANIELS, Ltd., Engrs., Stroud, Eng.
See displayed Advt. last and next week. 806

THE STEAM FITTINGS CO. LTD.
WEST DRAYTON, MIDDX.
AUTOMATIC TEMPERATURE REGULATORS FOR ALL PURPOSES.
PRESSURE REDUCING VALVES.
EXPANSION STEAM TRAPS.
ILLUSTRATED CATALOGUE ON APPLICATION.

BELLISS & MORCOM,
BIRMINGHAM. LTD.
Self-lubricating Steam Engines, Turbines, Air & Gas Compressors, Condensing Plants, Heavy Oil Engines, Paraffin Engines, Pneumatic Hose Couplings.
See Illustrated Advt. every month. 541

STONE AND COAL CRUSHERS
ENG.
LEICESTER
GOODWIN BARSBY & Co

THE STEEL PIPE CO.
LIMITED,
KIRKCALDY, N.B.
777
See our large Advertisement on alternate weeks.

Entwisle & Gass, Ltd.,
Engineers, BOLTON, Lancs.
RUBBER MACHINERY.
Special Patent Washing Machinery for Plantation Use. 1158

Telephone: No. 296 Smethwick (4 Lines).
Telegraphic Address: "Carriage," Smethwick, Birmingham.
Grand Prix, Buenos Ayres Exhibition, 1910.

THE BIRMINGHAM RAILWAY CARRIAGE AND WAGON CO., LTD.,
SMETHWICK.
FOR HOME AND ABROAD.

MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION, INCLUDING ALL-STEEL CARRIAGES.
9931
PRESSED STEEL UNDERFRAMES, BODIES AND BOGIES.
MAKERS OF RAILWAY WHEELS AND AXLES, IRONWORK, AXLE BOXES, CASTINGS, &c.

Sole Manufacturers of Dean & Churchward's Patent "Eitherside" Brake, and Marillier's Patent "Instanter" Coupling.

"HARTNELL" O 5445
GOVERNORS
WILSON HARTNELL & Co., LTD., VOLT WORKS, LEEDS.

ABBOTT & CO.
Telegraphic Address: "ABBOTT, NEWARK."
(NEWARK, LIMITED),
Telephone No. 34. ABC Code, 4th & 5th Editions.
NEWARK-ON-TRENT, ENGLAND.

WELDED & FLANGED WORK
OF EVERY DESCRIPTION.
CUSTOMERS' OWN PLATES WORKED AND FLANGED UNDER ADMIRALTY, BOARD OF TRADE, LLOYD'S, OR OTHER SURVEY, IF REQUIRED.

CONTRACTORS TO THE ADMIRALTY, WAR OFFICE, INDIA OFFICE, BOARD OF CUSTOMS, CROWN AGENTS, &c. &c.

DEGREASING PLANTS.
MOTOR VAN BOILERS
HYDRO CASINGS.
REPAIR FIRE BOXES.
EVAPORATOR SHELLS.
AIR RECEIVERS.
VULCANISING PANS, &c., &c.

FROM PHOTO. 9256

HENDERSON & GLASS,
LIVERPOOL.

Extensive Stocks of every description and Section of

MALLEABLE IRON AND STEEL

Including all sizes of Round, Square, and Flat Bars, Rolled Girders from 3 in. to 20 in. deep; Tees, Angles, &c., &c.

GREAT VARIETY OF HEAVY-SIZED 9783

PLAIN AND CHEQUERED PLATES

Boiler and Tank Plates, &c., in Iron and Siemens Steel.

Quotations and Sections on application.
Shipment Orders promptly executed. Correspondence Solicited.

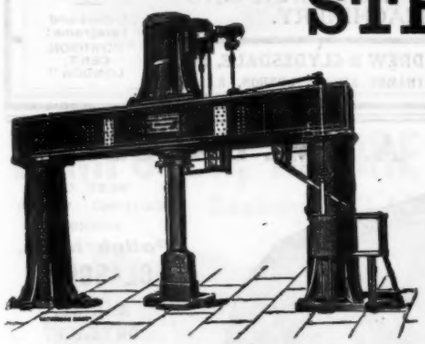
MINE VENTILATION
WITHOUT
FIRE RISK.

The TYPHOON TURBINE BLOWER, driven by compressed air, requires neither belts nor electric motor. Easily installed.

Prices and Particulars from Makers—

MURRAY, McVINNIE & CO., LTD.,
MAVISBANK, GLASGOW. 9840

STEAM HAMMERS



FOR SMITHS' SHOPS AND FORGES

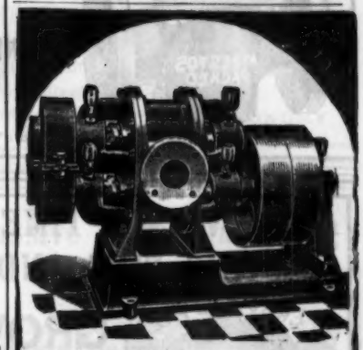
Shipbuilders' and Boiler Makers' Machine Tools.

PATENT BEVELLING MACHINES
FOR SHIPS' FRAMES.

FORGECRANES, Hand & Steam.

Sugar Cane Mills. Water Wheels, &c.

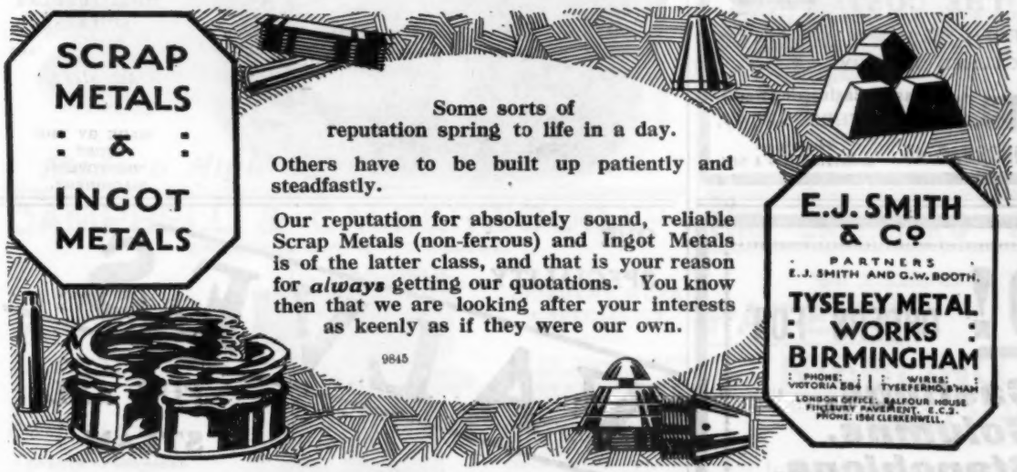
DAVIS & PRIMROSE,
Limited,
BANGOR WORKS, LEITH, EDINBURGH. 815



DRUM PUMP

SEND for CATALOGUE No. 90. IT WILL BE OF INTEREST TO YOU.

— THE —
DRUM ENGINEERING CO.,
LTD.,
22, HUMBOLDT ST.,
BRADFORD.



SCRAP METALS : & : INGOT METALS

Some sorts of reputation spring to life in a day.

Others have to be built up patiently and steadfastly.

Our reputation for absolutely sound, reliable Scrap Metals (non-ferrous) and Ingot Metals is of the latter class, and that is your reason for *always* getting our quotations. You know then that we are looking after your interests as keenly as if they were our own.

9845

E.J. SMITH & Co

PARTNERS
E.J. SMITH AND G.W. BOOTH.

TYSELEY METAL : WORKS : BIRMINGHAM

PHONE: VICTORIA 594 | WIRES: TYSEFERNO, B'HAM

LONDON OFFICE: BALFOUR HOUSE FINSBURY PAVEMENT, E.C.2. PHONE: 1561 CLERKENWELL.

REDUCING VALVES
FOR ALL
DUTIES.

Valves for Reduction of pressure in Steam, Gas, Water and Compressed Air Supplies.

Steam Reducing Valves for Reduction of High Pressures down to any pressure above atmospheric.

Built in various designs, in all sizes, ¼ in. to 16 in.

Valves for governing and automatically controlling Steam Supply as Pump Governors, Automatic Water Supply and Thermostatic control Valves.

Always RELIABLE and EFFICIENT.

Full details on application.

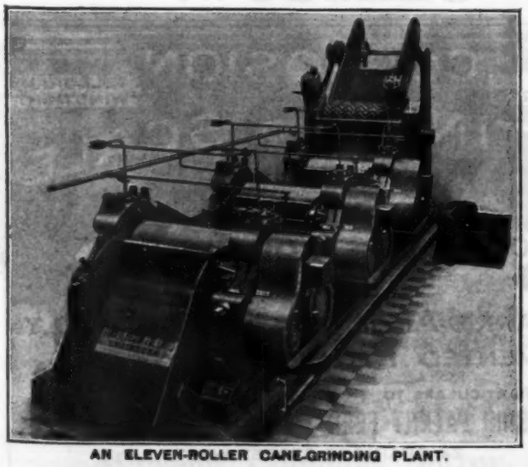
9818

BRITISH STEAM SPECIALTIES Lᵀᵈ.
BEDFORD STREET, LEICESTER.

FAWCETT, PRESTON & CO., Ltd.,
ENGINEERS, LIVERPOOL.

CONTRACTORS TO THE ADMIRALTY AND WAR OFFICE.

Telegrams: FAWCETT, LIVERPOOL. Codes used: A 1, A B C (4th and 5th Editions) and Western Union ("Universal" and "Five Letter" Editions).



AN ELEVEN-ROLLER CANE-GRINDING PLANT.

SUGAR MAKING PLANT of all kinds.
Complete Factories Supplied.

Sea Water DISTILLING PLANT.

DISTILLING and EVAPORATING PLANT for all purposes.

Hydraulic BALING PRESSES.

Sole Makers of CYCLONE and GRID PRESSES, and of Fawcett's High Density Presses and Pumps for packing Cotton, Jute, Wool, Hides, &c., of any required density and weight of bale.

EXPLOSIVES PLANT.

NITRATE-MAKING PLANT.

MARINE and STATIONARY ENGINES and BOILERS.

PUMPING MACHINERY for Towns Water Supply.

COPPERSMITHS and BRASS FOUNDERS.

9833

LONDON Office: 69, Victoria St., S.W. 1.

ON ADMIRALTY AND WAR OFFICE LISTS.

PEGLER BROS. & CO. (Glasgow), LTD.

Registered Office: 54, BROWN STREET,

Works:—Bridgeton Smelting Works, Fordneuk Street, **GLASGOW.**

BRASS & IRONFOUNDERS.

MAKERS OF ALL KINDS OF HIGH CLASS
ENGINE & BOILER FITTINGS.

MAKERS OF
SANITARY & WATER FITTINGS.

9084

Catalogue on application.

Tele.: "GUNMETAL." 'Phone: 3240 CENTRAL.

ELEVATORS **ROWNSONS** CONVEYORS

FOR THE MOST MODERN TYPES OF

CONVEYERS
ELEVATORS
GRAVITY RUNWAYS 553

WE ARE ACTUAL MANUFACTURERS — ESTABLISHED 100 YEARS.

ELEVATOR-CONVEYERS
COAL & ASH HANDLING
MACHINERY.

ROWNSON DREW & CLYDESDALE, Ltd.,
225, UPPER THAMES STREET, LONDON, E.C. 4.

Telephones: CENTRAL 1070.
Cables and Telegrams: "ROWNSON, CENT, LONDON."

WHY WASTE TIME AND MONEY ON FITTING PINS AND CASTLE NUTS?

WHEN

GROVER (Spring Lock Nut) **WASHERS**

SERVE THE SAME PURPOSE
at HALF THE COST.

BUT BEWARE OF IMITATIONS. 3961

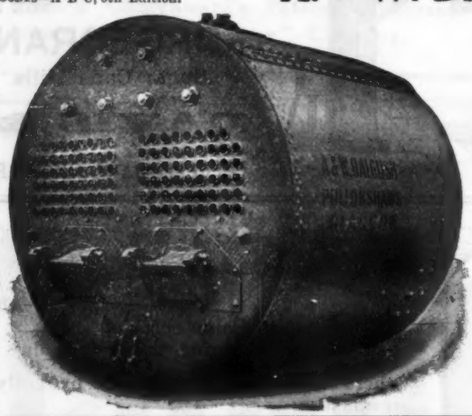
THE GENUINE ARTICLE IS MANUFACTURED ONLY BY

GROVER & CO., LTD., Britannia Engineering Works, CARPENTERS ROAD,

Telegraphic Address: "ADOPTED, STRAT, LONDON." **STRATFORD, LONDON, E. 15.** Telephones: STRATFORD 984 & 985.

TELEGRAMS—*Evaporate, Pollokshaws.*
CODES—A B C, 5th Edition.

A. & W. DALGLISH,



WEST OF SCOTLAND BOILER WORKS,
Pollokshaws,
GLASGOW.

MARINE, DRYBACK, LOCOMOTIVE and MULTITUBULAR BOILERS.

9303

ALL SIZES.

MADE BY THE MOST IMPROVED MACHINERY.

WANTED! ORDERS FOR

Head Office:
CORPORATION STREET,
BIRMINGHAM.

London Office:
25, VICTORIA STREET,
WESTMINSTER, S.W. 1.

Castings, Columns, Stanchions, Etc. 819

By

E. C. & J. KEAY, LTD.,
DARLASTON.

OUR SPECIALITY.

VALVES

9765

FOR ALL STEAM PURPOSES

A. COCKBURN & Co.

THISTLE VALVE WORKS, GATESIDE STREET,
GLASGOW.

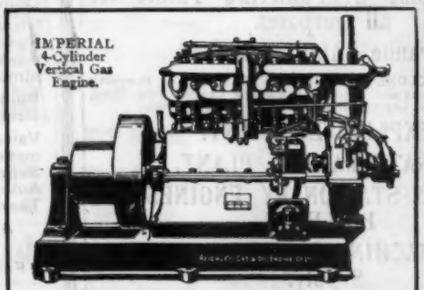
IMPERIAL ENGINES

for every
Industrial Requirement.

RELIABLE
EFFICIENT 9888

Write for particulars

KEIGHLEY
GAS & OIL ENGINE Co., Ltd.,
IMPERIAL WORKS, KEIGHLEY.



GAS · OIL & IMPERIAL KEIGHLEY SPIRIT · ENGINES

PHONE: CENTRAL 3220

CORROSION

TELEGRAMS: "WINDTIGHT."

PITTING AND SCALE

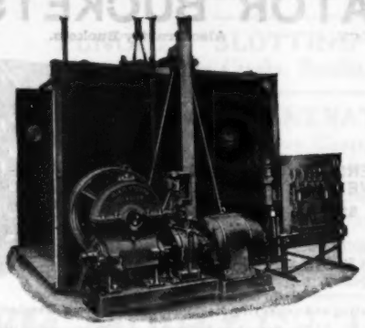
CAN BE PREVENTED
IN
CONDENSERS, BOILERS, ETC.,
BY INSTALLING
THE "HARRIS-ANDERSON" ELECTRICALLY AUGMENTED PROTECTIVE SYSTEM. 9839

WRITE FOR PARTICULARS TO
THE HARRIS PATENT FEED WATER FILTER (1910) LTD.,
24 GRAINGER STREET WEST.
NEWCASTLE-ON-TYNE.

LIFTS. **A. & P. STEVEN,**

181, St. James' Rd.

GLASGOW.



London Office:
10, CHARLES STREET,
BLACKFRIARS, S.E. 1.

Manchester Office:
12, CHARLES STREET.

T16

Birmingham:
HARRY ASTBURY,
DAIMLER HOUSE,
PARADISE STREET.

NICKEL CHROME ALLOYS MELTING POINT 1420°C.

TENSILE STRENGTH AT 1000°C. 12/15 TONS PER SQR. INCH

"Cronite"

T99

FOR RESISTING HEAT CONDITIONS WHERE OTHER METALS COLLAPSE

LOCOMOTIVE PARTS—HEAT TREATMENT VESSELS

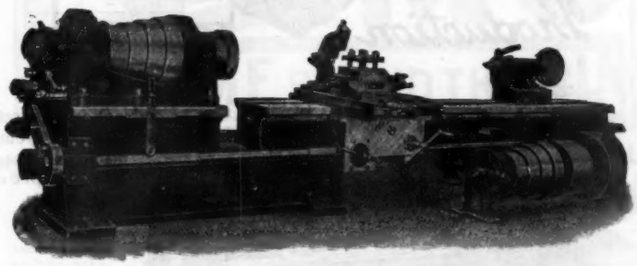
REDUCED WEIGHT — EFFICIENCY

The Cronite Foundry Company Ltd.
30, Lawrence Road, Tottenham, N.15
Telegrams—Croniteloy Totcross London
Telephone—1637 Tottenham

LONG LIFE — ECONOMY

DEMPSTER, MOORE & CO., LTD.,

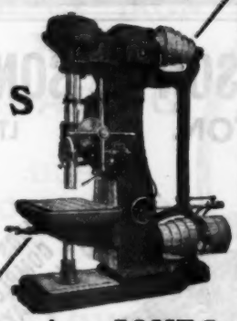
Engineers, GLASGOW.



8117

Modern High-Speed Machine Tools.

J & S



Massive Manufacturing Machines

designed to withstand the strain of the most exacting working conditions. Every part is made to Newall limits and all machines are thoroughly tested before going out. All Pulleys, Gears, Spindles, &c., are of *extra size giving power much beyond that of the average* DRILLING MACHINE. 28 Models.

9695

A. A. JONES & SHIPMAN, LTD.,

LEICESTER.

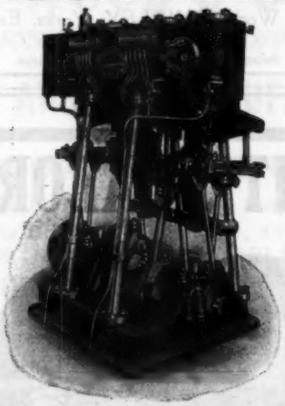
CAMPBELL & CALDERWOOD, LD.

ENGINEERS AND SHIPBUILDERS,

Soho Works,
PAISLEY,
SCOTLAND.

CONTRACT for Vessels Complete for Shipment in Pieces or in Sections.

Telegraphic Address:
"SOHO," PAISLEY.



SHIPMENT WORK A SPECIALITY.

All Types SCREW ENGINES, SIDE AND STERN WHEEL PADDLE ENGINES Designed for Lightest Draft and Speed. Smallest Size ENGINES, up to 1500 HP. Independent STEAM-DRIVEN CONDENSING PLANT. Independent STEAM-DRIVEN CENTRIFUGAL PUMPS.

CATALOGUES ON APPLICATION

784

Codes:
Marconi International;
Engineering;
A B C (5th Edition).

THE ENGINEER'S GREAT LABOUR SAVER.

WILSON'S

PATENT NIBBLING MACHINE

Indispensable for the making of Cast Steel Gauges

WILL QUICKLY CUT TO ANY DESIGN ALL KINDS OF SHEET METAL.

605

Write for prices and sample of work

J. B. STONE & CO., Ltd., 135, Finsbury Pavement, London, E.C.2.

"WOODITE,"

The Best Material for ***GAUGE GLASS RINGS & STEAM PACKINGS***

For Valves, Joint Rings, Pump Cups, Ram Rings, Packing Rings and Sheeting in all Sizes and Sections.

Contractors to H.M. Government, Admiralty, War Office, Post Office, India Office, and the Colonial and Foreign Governments.

The Best Material for all High Pressure Steam or Electrical Installations.

9189

PRICE LIST AND FULL PARTICULARS ON APPLICATION TO—

WOODITE COMPANY,

Mitcham Common, Surrey, Eng.

Tel. Address: "Woodite, Mitcham." Telephone No.: Mitcham, 1502.

SUBMERSIBLE MOTORS LTD.

'Phone—SOUTHALL 12. **SOUTHALL, Middx.** Telegrams—SUBMERSE, SOUTHALL.

A.C. & D.C. MOTORS, DYNAMOS, ALTERNATORS & MOTOR GENERATORS

Enclosed Ventilated Ball Bearing Dynamo.

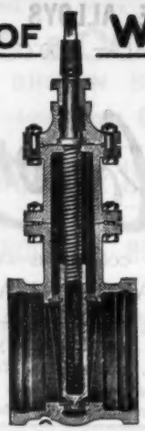
SPECIALITY—
SUBMERSIBLE ELECTRIC MOTORS FOR PUMPING AND WET POSITIONS.

800

THEY WORK IN WATER.

CONTROL OF WATER.

ORIGINAL MANUFACTURERS OF
Chrimes' High Pressure Loose Valve Screw-down Cocks.
GUEST & CHRIMES' TURBINE WATER METERS.
(Siemens & Adamson's).
WATER WORKS FITTINGS.
SURFACE BOXES.
640
Telegrams—
"GUEST, ROTHERHAM."



GUEST & CHRIMES IMPROVED SLUICE VALVES for Water, Steam, Sewage, Gas & Oil.
LONDON OFFICE—
4 & 5, ADAM ST., ADELPHI, W.C. 2.
Telegrams—
"Birbinchri, Westrand, London."
Telephones—
Gerrard 3636 and 1376.
Telephone—
205 ROTHERHAM.

GUEST & CHRIMES, Ltd., - ROTHERHAM.

SEAMLESS STEEL AND RIVETTED ELEVATOR BUCKETS.

100,000 to 250,000 ALWAYS IN STOCK. Also Gravity Buckets.

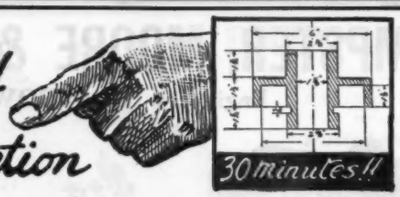
MAKERS OF OVER 800 sizes.
Specify Braime's Buckets for Quality.
Full Illustrated Price List on application.
To be had from all Makers of Elevating and Conveying Machinery, or Engineers' Merchants. 9279
T. F. BRAIME & CO., LTD., The Seamless Stamping and Engineering Works Hunslet, Leeds, ENGLAND.

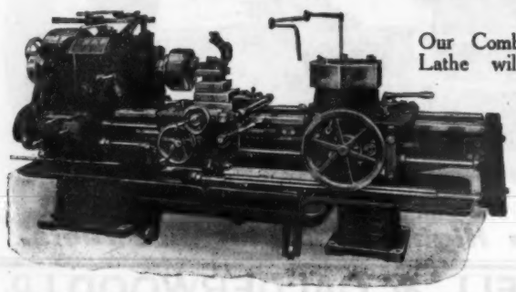
THOMAS SUMMERSON & SONS, LTD.
DARLINGTON.

SWITCHES AND CROSSINGS.
SIDINGS SUPPLIED COMPLETE INCLUDING PLATELAYING.

BUFFER STOPS, TURNTABLES and RAILWAY ACCESSORIES OF ALL KINDS.
9686
CASTINGS in IRON or STEEL.
Telegrams: "SUMMERSON, DARLINGTON."
LONDON OFFICE: 32, Victoria Street, S.W. 1.

Rapid Production

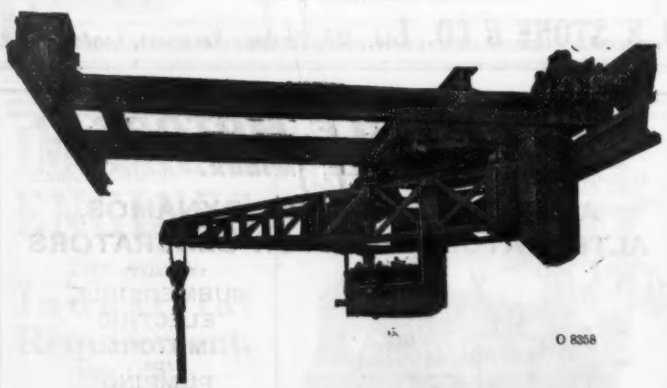




Our Combination Turret Lathe will bring your machining costs below pre-war level.
OVERSEAS AGENTS WANTED.

BARKER, SPINK, LEASE & CO.,
Park Works, SHIPLEY, Yorks, England.
Cables—LATHE, SHIPLEY. *Code—A.B.C. 5th Edition.*
AGENTS: AUSTRALIA—Selson Engineering Co., Ltd., Melbourne. 705

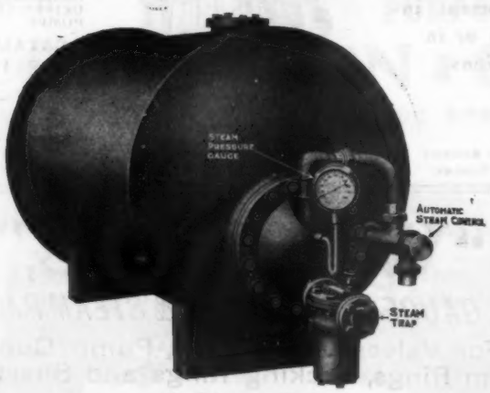
HIGGINBOTTOM & MANNOCK, LD.
Crown Iron Works, West Gorton, MANCHESTER.
Telegrams:—CROWN, GORTONBROOK.



O 8358

Electric Cranes, Hoists, Capstans, Winches, Traversers, Transporters, Hauling Machinery and Hand Cranes, Hand and Power Runways, Pulley Blocks.

WRIGHT'S CALORIFIERS



SEND YOUR ENQUIRIES FOR:— CALORIFIERS OF ANY SIZE FOR ANY PURPOSE; FOR USE WITH EITHER LIVE OR EXHAUST STEAM
TO:—
WRIGHT'S FORGE & ENGINEERING CO., LD.
PHONE—32 Tipton. 6585 London Wall.
WIRE—Forgings, Tipton. Penetration, Stock, London.
TIPTON, Staffs. AND 57, Bishopsgate, LONDON, E.C. 0 8758

MUIR
MACHINE TOOLS.

PUNCHER SLOTTING MACHINES
For Cranks, Buckles, &c.

GEAR GENERATORS
For Tramway Gears, &c.

GEAR HOBBING MACHINES
For Turbine Gears.

LOCOMOTIVE MACHINE TOOLS. 9383

WM. MUIR & Co., LTD., MANCHESTER.

ELECTRIC STEEL CASTINGS
606

MILD STEEL CASTINGS Ltd
TYSELEY, BIRMINGHAM.

FREMO
THE NAME BEHIND THE PIN

FOR TAPER PINS, ACCURATELY MACHINED,
WRITE 580
FRED^K. MOUNTFORD,
FREMO WORKS, OLD CROSS STREET,
Delivery ex Stock. BIRMINGHAM. Any Size. Any Taper.

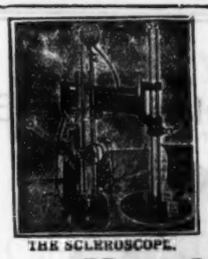
SHEET IRON WORK.
HEATING and DUST COLLECTING PLANT. 9675

Welded Piping & Cyclone ¼ in. Thick.

DALLOW, LAMBERT & CO., Ltd.
63, Queen Victoria St., LONDON. King St., LEICESTER.

HENRY WOOD & CO., Ltd.
SALTNEY, Near CHESTER.

CHAIN AND ANCHOR MANUFACTURERS,
Works adapted to make up to the LARGEST SIZES.
LARGE MOORINGS A SPECIALITY.
BATTLESHIPS' CABLES and GEAR.
Forgings, Crane Chain, Chain Slings, and all kinds of ANCHORS, MOORING and CABLE GEAR.
WOOD'S "VIKING" STOCKLESS ANCHOR.
Standing Contractors to the British Admiralty, Trinity House and Public Bodies, and Contractors to all
FOREIGN GOVERNMENTS. 556



THE SCLEROSCOPE.

For Hardness Testing
in shop and laboratory use the
Standard Scleroscope
Universally adopted; direct reading; inexpensive, and the only instrument that agrees with others of its kind in all parts of the World, thus solving problems of ordering materials to specification.

BOOKLET FREE. 9553

Hentsa objects as seen through Pyroscope.

Heat Indication,
by optical means is fast becoming the correct thing. The PYROSCOPE has solved the problem. Perfect constancy, inexpensive, no electricity used. Built to stand rough usage and upon common-sense lines. Used by the Governments and best Firms.

SHORE INSTRUMENT & MFG. CO., New York.
Agents for England:—COATS MACHINE TOOL CO., LTD.,
14, Palmer St., Westminster, London, S.W. Glasgow & Newcastle-on-Tyne.

THE PYROSCOPE.

MACHINE CUT WHEELS.

WORM AND SPUR REDUCING GEARS.

9736
The REID GEAR CO.,
LINWOOD,
near PAISLEY.

BRIGHT DRAWN STEEL BARS. 908

HALESOWEN STEEL Co LTD

HALESOWEN

BIRMINGHAM

Bright Drawn Steel Manufacturers with Output of 3000 Tons Monthly.

Rounds. 3/16 in.–5 in. Hexagons. ·312 in.–2·757 in. a/f.

Squares. 3/4 in.–2 in.

All the above Sections manufactured in any quality, and to any Specification or Tests.

9839

Millions of Pounds' worth of HEAT wasted

Will you consider a proved method of utilizing waste heat?

If you have retorts, furnaces, coke ovens, or large gas engines, you can convert their waste heat into steam by means of

KIRKE PATENT WASTE-HEAT BOILERS
OR
SPENCER-HOPWOOD PATENT WASTE-HEAT BOILERS

which are made specially to individual requirements, thus ensuring maximum saving at least cost.

Why burn expensive coal or coke when all this waste heat is available? Wasted heat is wasted money.

These waste-heat boilers mean bigger dividends because they save £. S. D. One of our waste-heat boilers fitted to a furnace in continual operation, evaporating 5,000 lbs. of steam per hour, will save 2,000 tons of coal (say £4,000) per annum.

Let us tell you how much YOU can save. Write

SPENCER-BONECOURT LTD.
BOILERMAKERS AND ENGINEERS
PARLIAMENT MANSIONS, VICTORIA STREET, LONDON, S.W. 1
'Phone: Victoria 5563. Telegrams: 'Bonecourt,' Phone, London. Works: Hitchin, Herts.

5578

BRETT

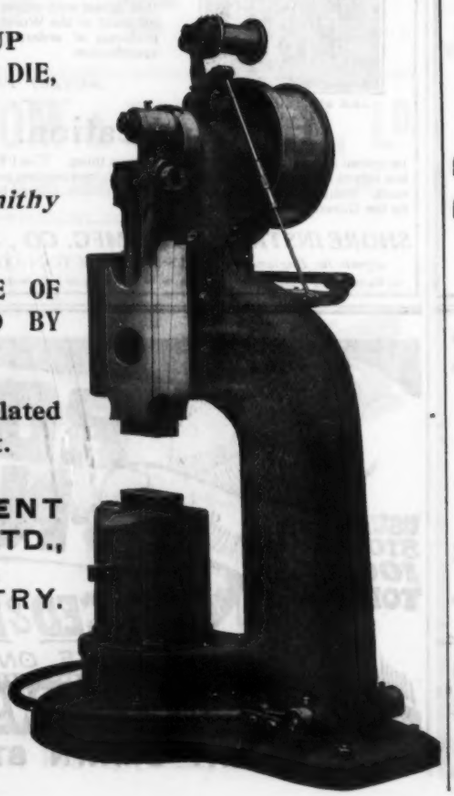
TAGGING and FORGING HAMMER.

WEIGHT OF TUP EXCLUSIVE OF TOP DIE, 200 lbs.

Made by Specialists in Smithy Equipment.

SPEED AND FORCE OF BLOW CONTROLLED BY FOOT LEVER.

Stroke can be Regulated by Adjustment.



BRETTS PATENT LIFTER CO., LTD.,
Foleshill Works,
COVENTRY.

'PHONE 1102.

TELEGRAMS:
"LIFTERS,"
COVENTRY.

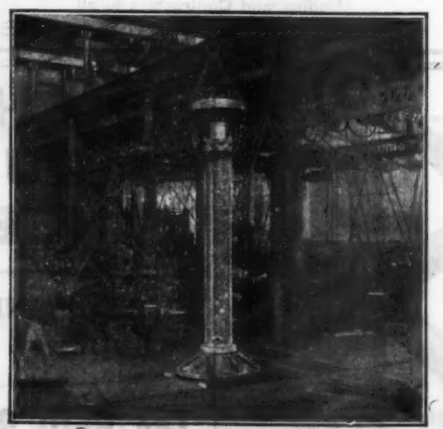
THE BUTTERLEY CO., Ltd.

DERBY. ESTABLISHED 1791.

Telephone—Nos. 75 and 76, RIPLEY. Telegrams—"IRONWORKS, BUTTERLEY.

Pig Iron, Bar Iron, Iron Castings
Up to **20** Tons.

Bridge and Structural Steelwork, Pit Trams, &c.
High-Class Machine Work of all descriptions.



9868

Special Acid-Resisting Metal for Chemical Plants.
Large Retorts, Pans, Acid Eggs, &c., a Speciality.

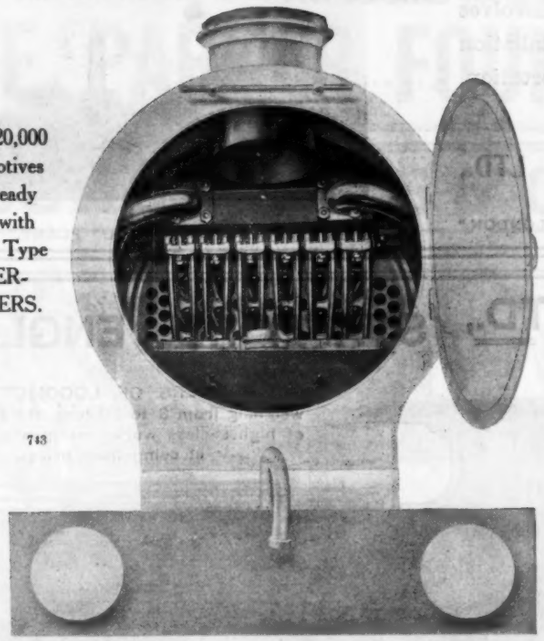
LONDON OFFICE—52, Queen Victoria Street. Telephone—2180, CITY.

275° F. to 300° F. SUPERHEAT.

A Steam Consumption Economy of 33 per cent., Fuel Economy of 24 per cent. nett, from the use of

M.L.S. SMOKE TUBE SUPERHEATERS.

Over 120,000 Locomotives are already fitted with M.L.S. Type SUPER-HEATERS.



743

Marine and Locomotive Superheaters, Limited,
195, Strand, London, W.C.

Telephones: City 3263—3264.
Telegrams: "Supertemp, London."

Cradley Cross Tube Boilers

In

STOCK

and

PROGRESS

For **LAND** and

MARINE USE.

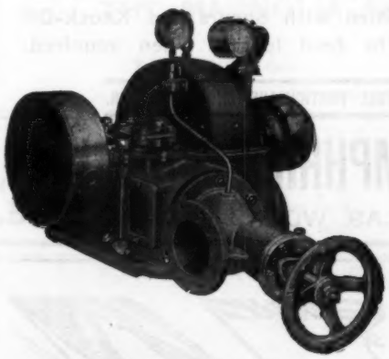
838

CRADLEY BOILER CO., LTD.

CRADLEY HEATH, STAFFS.

HYDRO-ELECTRIC

IMPULSE UNITS.



TURGO IMPULSE TURBINE WITH PATENT **SHAFT GOVERNOR** FOR COUPLING DIRECT TO GENERATOR.

WE GUARANTEE SPEED RISE WITH FULL LOAD SUDDENLY THROWN OFF NOT TO EXCEED

2%

9646

GILBERT GILKES & CO., LTD., KENDAL, ENGLAND

FOWLER LEEDS.

Cultivating Machinery.
Cable Systems, Tractors, Motor Ploughs.

Road Transport Machinery.
Traction Engines, Road Locos, Wagons.

Road Making Machinery.
Steam Rollers, Scarifiers, Tar-sprayers, &c.

Light Railway Machinery.
Plant, Locomotives, Rolling Stock.

JOHN FOWLER & CO. (LEEDS) LTD.
Steam Plough & Locomotive Works,
LEEDS.

9394

London Office: **113, CANNON STREET, E.C. 4.**

Success and the Ropeway!

The success of an undertaking depends chiefly upon financial management. Good financial management always involves careful forethought to economy. An Aerial Ropeway installation is the most efficient and economical means of transportation.

THE AERIAL ROPEWAY MEANS SUCCESS.

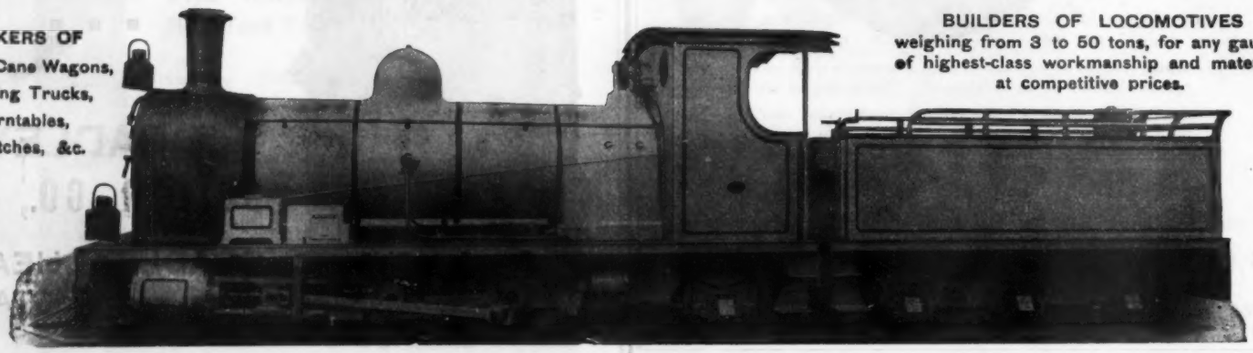
THE BRITISH ROPEWAY ENGINEERING CO., LTD.,
7, MINCING LANE, LONDON, E.C. 3.
Telephone—CENTRAL 11250. Telegrams—"BOXHAULING, FEN, LONDON."

VIEW OF "BRECO" PLANT. 9782

W. G. BAGNALL, LTD., STAFFORD, ENGLAND.

MAKERS OF
Sugar Cane Wagons,
Tipping Trucks,
Turntables,
Switches, &c.

BUILDERS OF LOCOMOTIVES
weighing from 3 to 50 tons, for any gauge, of highest-class workmanship and material, at competitive prices.


Od651

Patent Rod Straightening and Cutting-off Machine.

STRAIGHTENING MACHINES
FOR COILED OR DRAWN RODS.
(Patent No. 113507/1917.)

No Friction Roll Feed to mark work. Rods are pulled through Machine by high-speed Chain. These Machines can be fitted with Shears and Knock-Off Gear for cutting to dead length when required.

PRICES AND FULL PARTICULARS ON APPLICATION.

FISHER, HUMPHRIES & CO., LTD.,
ATLAS WORKS, PERSHORE.
9888

697

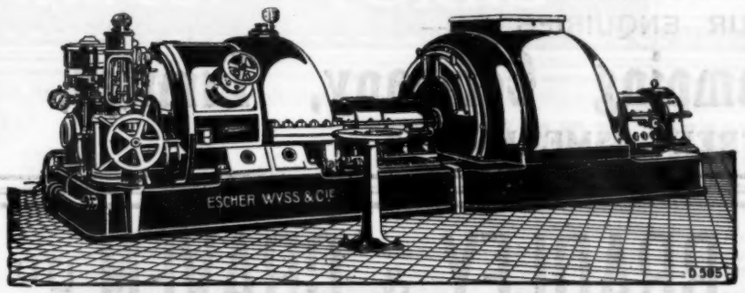
STEEL CASTINGS up to 6 TONS each.

To any reasonable specification.

ALSO MALLEABLE IRON CASTINGS. 564

THE PARKER FOUNDRY Co., LTD., DERBY.

ESCHER WYSS & Co., S.A., Zurich (Switzerland)



Zoelly Steam Turbines

Turbopumps - 761

Water Turbines 34/23

TOKYO Office: 3, Uchisaiwaicho Itchome Kojimachi-Ku

AGENTS FOR CANADA:

LONDON Office: 20, Grosvenor Gardens, London, S.W. 1. TELEPHONE: Victoria 9130. TELEGRAPHIC ADDRESS: ESWYSCO-SOWEST, LONDON. General Supply Co., Ottawa.

Official tests and thousands of testimonials prove that

"Flower Brand" Magnolia Metal

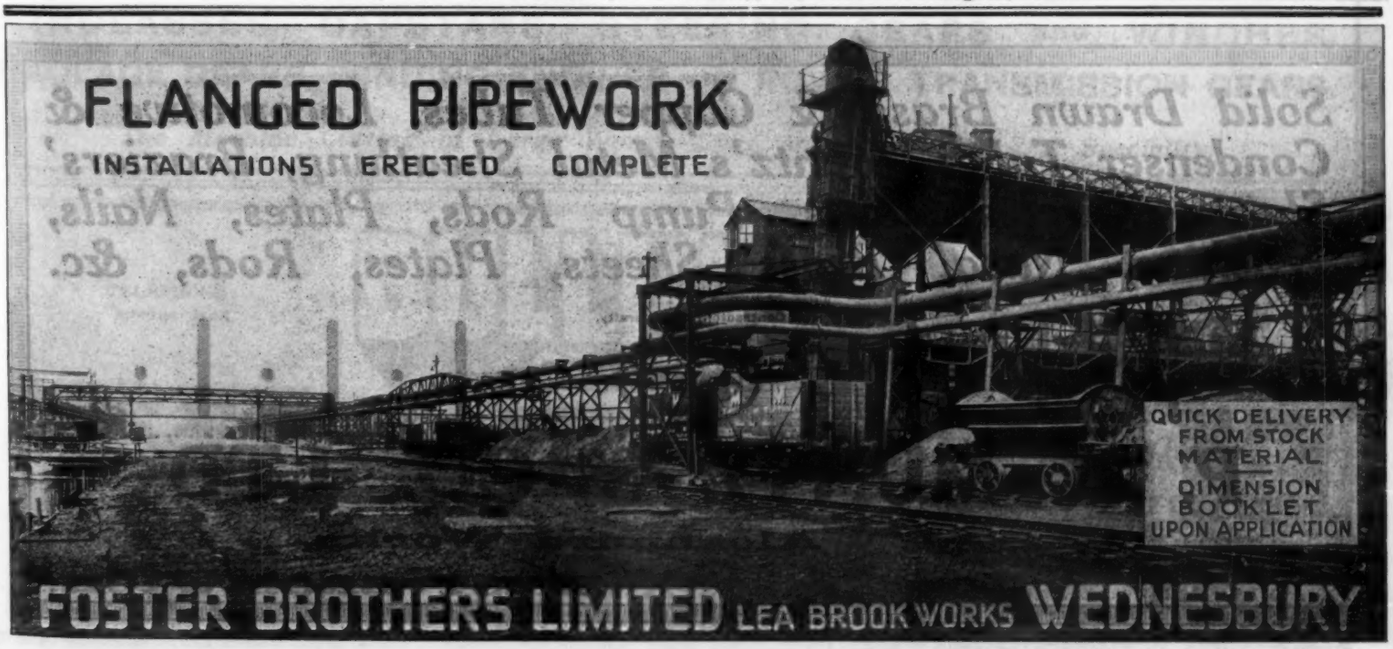
Has lowest co-efficient of friction. Stands highest speeds and pressures.

THE MAGNOLIA ANTI-FRICTION METAL CO. OF GREAT BRITAIN LIMITED,

49, Queen Victoria Street, London, E.C. 9573

Telephone: City 6596. Telegrams: Magnolier, Cannon, London.

(France): LA MAGNOLIA (A. G. Miller), 21, Rue de Petrograd, Paris.


FLANGED PIPEWORK
INSTALLATIONS ERECTED COMPLETE
QUICK DELIVERY FROM STOCK MATERIAL
DIMENSION BOOKLET UPON APPLICATION
FOSTER BROTHERS LIMITED LEA BROOK WORKS WEDNESBURY

DROP FORGINGS

FOR THE ENGINEERING TRADES MADE IN

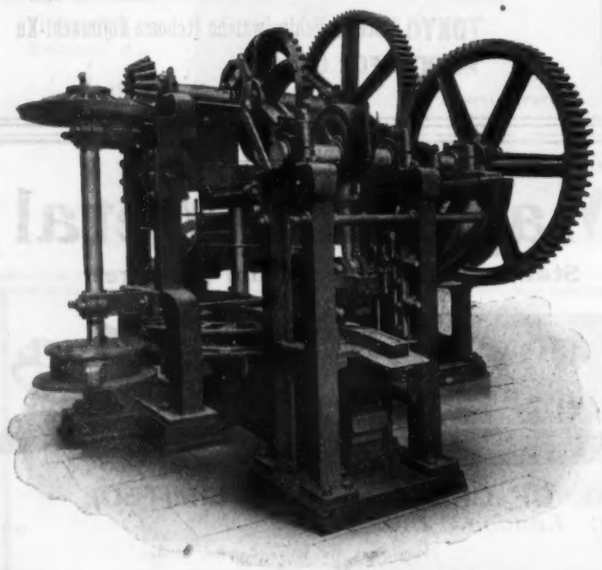
STEELS to any analysis, special attention being paid to the heating and working of Carbon, Nickel, Nickel Chrome, Chromium, Chrome Vanadium and other Alloy Steels.

HEAT TREATMENT carried out under the direct supervision of our laboratory to meet all Engineering Standards Committee, Air Board, Admiralty, War Office, and other Specifications and Tests.

SEND YOUR ENQUIRIES TO— 714

The Smethwick Stamping Company, Limited,

BRIDGE STREET, SMETHWICK.



BRADLEY & CRAVEN, LTD.

ESTABLISHED 1843. WAKEFIELD.

PIONEERS OF **STIFF PLASTIC BRICK MAKING MACHINERY.**

BRICKS PRODUCED BY OUR LATEST IMPROVED MACHINES ARE OF UNEQUALLED STRENGTH AND FINISH. READY FOR IMMEDIATE DELIVERY TO KILN.

No. 1 "STIFF-PLASTIC" BRICK-MAKING MACHINE, Output 1000/1200 per hour.

We also build a larger Machine (No. 2 size) for 1800/2000 per hour. D6325

HIGHEST OUTPUT——HIGHEST QUALITY.

Solid Drawn Brass & Copper Tubes, Locomotive & Condenser Tubes, Muntz's Metal Sheathing, Braziers' Sheets, Circles, Bolts, Pump Rods, Plates, Nails, Washers, Naval Brass Sheets, Plates, Rods, &c.

Contractors to Admiralty.

P. H. MUNTZ & CO., LTD., 9560

Alexandra Works,

WEST BROMWICH.

TUBES LIMITED

WELDLESS TUBES for BOILERS and STEAM PIPES
LOCOMOTIVES & THE ENGINEERING & MOTOR TRADES.

Works: ASTON MANOR, BIRMINGHAM. 3851

Tele{grams: CYLINDERS, phone: No. 871 & 872 E (4 lines).

J. Wigglesworth & Co Ltd
SHIPLEY ~ YORKS

783 FRICTION CLUTCHES

TRADE MARK

SKINNER UNIVERSAL CHUCKS

Geared Screw Type.

The most accurate chucks made. Inspected and accurate by test to within ·002 in. before leaving the shop. This extreme accuracy, uniform excellence and reliability explain the popularity of these chucks, particularly in shops where accuracy is paramount.

Equipped with the Skinner patented 2-piece reversible jaws, it is the ideal chuck for general machine shop and tool room work where a great variety of work is to be held.

Illustrated literature and catalogue upon request.

THE SKINNER CHUCK COMPANY
NEW BRITAIN, CONN. U.S.A.
established 1887.

9884

London Office: 139, Queen Victoria St., E.C. 4.

NAPIER BROTHERS, LTD., 130, HYDE PARK ST., GLASGOW, W.

Telegrams: Windlass, Glasgow.

GENERAL ENGINEERS.

Telephone: 6714 Central.

Contractors to ADMIRALTY, COLONIAL and FOREIGN GOVERNMENTS.

Steam, Hand, Electrical, Compressed Air and Petrol

WINDLASSES, CAPSTANS, STEERING GEARS and WINCHES.

HAULAGE GEARS, WINDING ENGINES and POWER TRANSMISSION GEARS.

The Machine Cutting of Large Worm, Spur and Bevel Gears a Speciality. 764

TELEPHONE: Avenue 2108.

BULLIVANT AND CO., LIMITED

TELEGRAMS: "Bullivants (Fen), London."

STEEL WIRE ROPES

For CRANES DERRICKS, HAULAGE, SUSPENSION-BRIDGES, CABLE-TRAMWAYS, AND

ALL ENGINEERING PURPOSES. 9618

BLOCKS, PULLEYS, CRAB-WINCHES, &c., &c.

Registered Offices: 72, MARK LANE, LONDON, E.C. 3.

Works: MILLWALL, LONDON, E. 14.

NORTH BRITISH LOCOMOTIVE CO., LTD.,

HYDE PARK WORKS (Late NEILSON, REID & Co.) | QUEEN'S PARK WORKS (Late DUBS & Co.) | ATLAS WORKS (Late SHARP, STEWART & Co., Ltd.)

ADMINISTRATIVE BUILDING, 110, FLEMINGTON STREET, SPRINGBURN, GLASGOW.

LONDON OFFICE: 17, VICTORIA STREET, WESTMINSTER, S.W. Telegrams—"LOCO., GLASGOW."

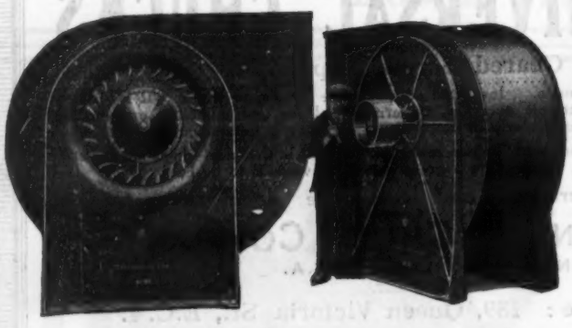
BUILDERS OF ALL KINDS OF

LOCOMOTIVE ENGINES AND TENDERS SUITABLE FOR ANY GAUGE OF RAILWAY. 608

Annual Capacity, 700 MAIN LINE LOCOMOTIVES. Output now exceeds 20,000 LOCOMOTIVES. Workshops equipment, 8000 MEN.

THE LARGEST LOCOMOTIVE WORKS IN EUROPE.

FOR ALL PURPOSES.



TRADE MARK.

FANS & BLOWERS

STANDARD & OSWALD STOTT (Engineers), LTD.,

Telegraphic Address: "BLOWING, LEICESTER." Evington Valley Road, LEICESTER. Telephone Nos.: 4761-2-3 LEICESTER.

MANCHESTER · GLASGOW · NEWCASTLE-ON-TYNE.

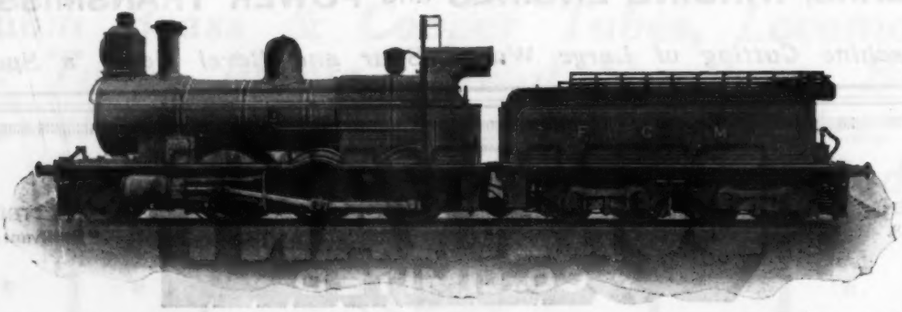
20 years' experience is at your service for the asking. 638

HUDSWELL, CLARKE & CO., LTD.,

RAILWAY FOUNDRY, LEEDS.

LOCOMOTIVES

For Main or Branch Railways, Contractors, Ironworks, Collieries, &c. Made to suit any Gauge of Railway.



Established 1860.

Telegraphic Address: "LOCO, LEEDS."

PRICES, PHOTOGRAPHS AND FULL SPECIFICATIONS ON APPLICATION. 9953

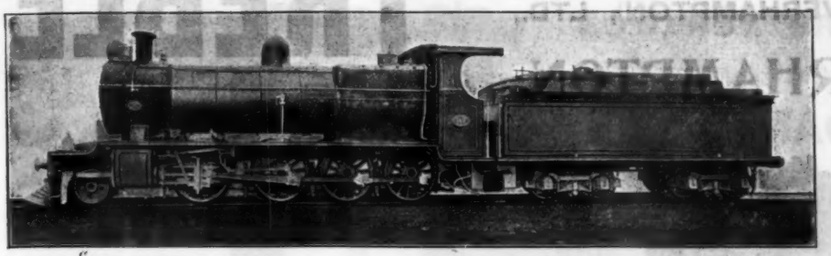
SOLE MAKERS OF

"RODGERS' PULLEYS"

(REGISTERED).

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

R. & W. HAWTHORN, LESLIE & CO., LTD.



LOCOMOTIVES

Of every description for Home and Foreign Railways.

TANK ENGINES AND COMBINED CRANES AND LOCOMOTIVES

ALWAYS IN STOCK AND IN PROGRESS.

For Collieries, Ironworks, Railway Depots, Branch Lines, Contractors, &c.

Telegraphic Address: LOCOMOTIVE, NEWCASTLE-ON-TYNE

ESTABLISHED 1817.

MARINE ENGINEERS AND SHIPBUILDERS. 9945 **NEWCASTLE-ON-TYNE.**

YORKSHIRE ENGINE CO., LTD.,

Builders of

ALL CLASSES & WEIGHTS OF

LOCOMOTIVES

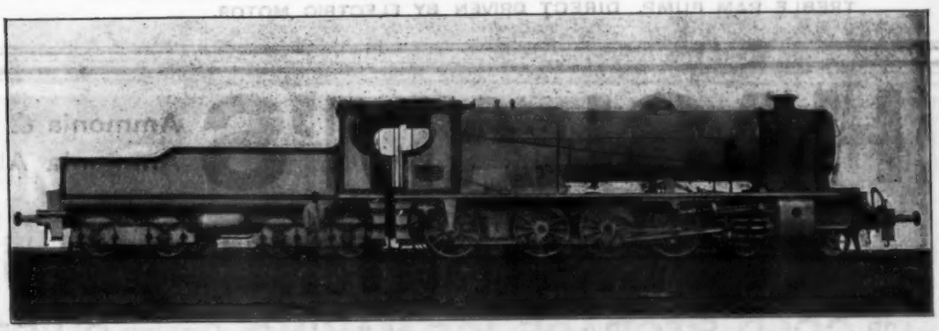
IRON & STEEL FORGINGS.
COAL CUTTING MACHINES.
HAULAGE ENGINES.
SOLID & BUILT-UP CRANKSHAFTS
LOCOMOTIVE CRANKS.
WHEEL & AXLE SETS.

Contractors to Admiralty, War Office, India Office, &c., and Colonial and Foreign Governments and Railways.

Telegrams—ENGINE, SHEFFIELD. 513

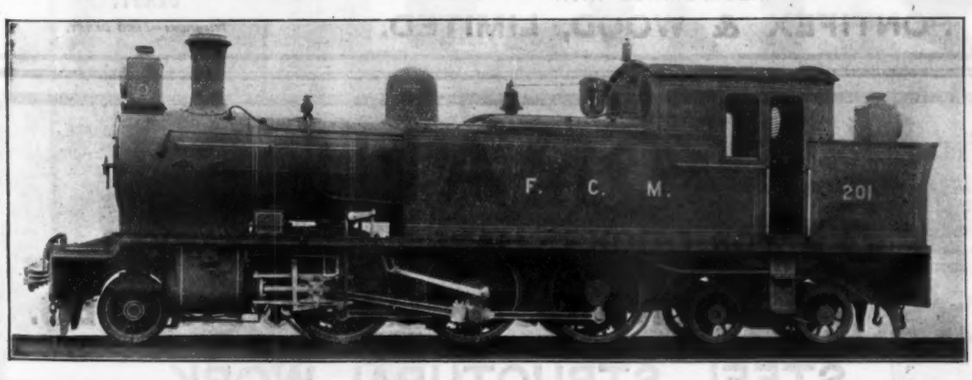
LONDON OFFICE—
15, Caxton House, Westminster, S.W.

HEAD OFFICE—MEADOW HALL WORKS, SHEFFIELD, Eng.



THE HUNSLET ENGINE CO., Ltd.,

LEEDS.



MAKERS OF 9019

LOCOMOTIVE ENGINES

Adapted to every variety of work and gauge.

DESIGNS & SPECIFICATIONS SUPPLIED OR WORKED TO.

Quotations & Specifications on application.

Telegraphic Address: "ENGINE, LEEDS."
Telephone:—Nos. 20877 (2 lines).

PECKETT & SONS, LTD.,

BRISTOL.

Telegrams - - Peckett, Bristol.

SPECIALITY

TANK LOCOMOTIVES

Of all Descriptions and any Size or Gauge.

Full Particulars on Application. 9989

JOSEPH EVANS & SONS

(WOLVERHAMPTON), LTD.,

CULWELL WORKS, WOLVERHAMPTON.

TREBLE RAM PUMPS.

TREBLE RAM PUMP. DIRECT DRIVEN BY ELECTRIC MOTOR.

511

HASLAM'S

Ammonia & CO_2 Compression Systems
Ammonia Absorption, Compressed Air

REFRIGERATING MACHINERY

O 1448

FOR COLD STORAGE, ICE-MAKING, &c., ON SHIPBOARD AND ASHORE

541-3, SALISBURY HOUSE, LONDON WALL, LONDON, E.C. 2.

THE HASLAM FOUNDRY & ENGINEERING CO., LIMITED,
INCORPORATED WITH
PONTIFEX & WOOD, LIMITED.

UNION FOUNDRY, DERBY.
Telegrams—ZERO DERBY.

25 Ton Electric Wharf Crane. 718

CRANES

FOR DOCKS - HARBOURS - WHARVES.

CAISSONS-DOCK GATES-BRIDGES.

STEEL STRUCTURAL WORK

REINFORCED CONCRETE BUILDINGS.

GENERAL CONTRACTING.

HYDRAULIC PUMPS-RIVETERS-PRESSES, &c.

SIR WILLIAM ARROL & Co LTD

GLASGOW.

(Agents in New Zealand—Messrs. CORY-WRIGHT & SALMON, Wellington, N.Z.)

FRANCIS BERRY & SONS,

SOWERBY BRIDGE, ENGLAND.

MAKERS OF

HEAVY MACHINE TOOLS.

Established 1832. Established 1832.

509

The Illustration represents our 20 ft. Plate Edge Planing Machine arranged for Motor Drive with non-reversing Motor.

ESTABLISHED 1793.

NEWTON, CHAMBERS & CO. LTD.

THORNCLIFFE IRONWORKS & COLLIERIES.

NEAR SHEFFIELD.

TANKS

IN CAST IRON OR STEEL

OF ALL SIZES FOR ALL PURPOSES.

521

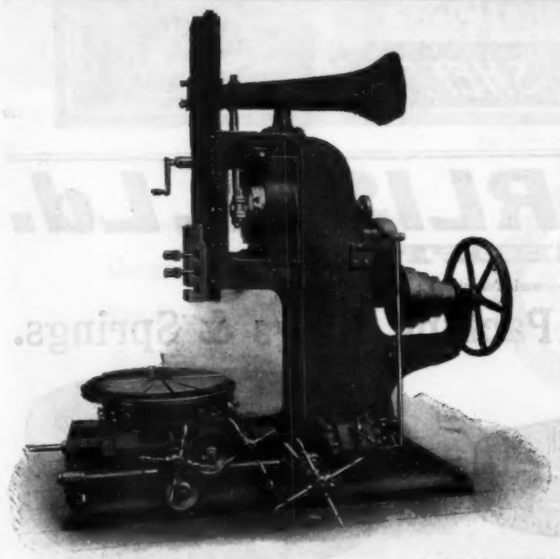


ILLUSTRATION OF 14 in. SLOTTING MACHINE.

FOR HIGH CLASS MACHINE TOOLS

Send your enquiries to

Noble & Lund, Ltd.,

Felling-on-Tyne.

Specialists in Planing Machines.
" " Cold Sawing Machinery.
" " High Speed Friction Saws.
" " Lathes. 9362
" " Drilling and Boring Machines
" " Slotting and Shaping Machines.

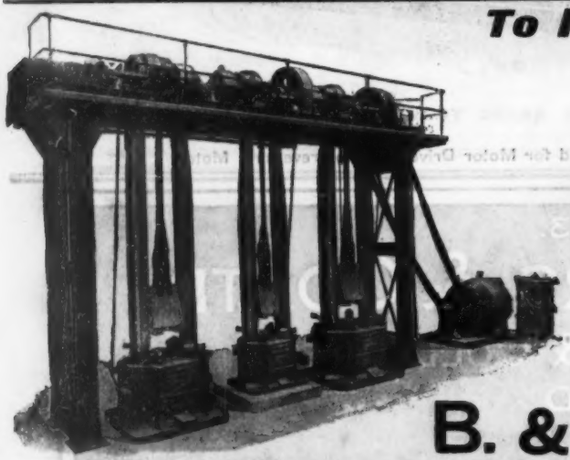
McKIE & BAXTER

ENGINEERS, SHIPBUILDERS, BOILERMAKERS, COPLAND WORKS, GLASGOW.

Telegrams: "CALIDAD, GLASGOW." Codes: A 1, A B C, Engineers and Private Code. 780

SPECIALITY.—MACHINERY FOR VESSELS CONSTRUCTED ABROAD.

Correspondence Invited.



To Increase Output and Decrease Cost,

USE OUR MODERN

HAMMERS AND STAMPS

9912

B. & S. MASSEY, LTD., MANCHESTER.

HOWELL'S

TRY SWING

FILES

LARGE CONTRACTORS TO THE ADMIRALTY INDIA OFFICE AND WAR OFFICE.

LONG LIVED FILES OF FINEST QUALITY & DURABILITY.
FILES & RASPS OF EVERY DESCRIPTION.

HOWELL & Co LTD Brook Steel Works, SHEFFIELD.

530

LOCKWOOD & CARLISLE, Ld.

EAGLE FOUNDRY, SHEFFIELD.

Telegraphic Address: "PISTON, SHEFFIELD." National Telephone: 1376.

Improved Double-action Metallic Piston Packing Rings & Springs.

Improved Double-action Piston Valve Rings.

CARLISLE'S PATENT.

9939

SPECIAL FACILITIES FOR QUICK DESPATCH OF URGENT ORDERS.

As Fitted in S.S. "BRITANNIC."

H.P. Rings and Springs specially designed for High Steam Pressures.

SUPERHEATERS.

Any tube easily removed and replaced in a few minutes without disturbing the brickwork or header.

STEAM PLANT ECONOMY.

Equip your Boilers with

"THOMPSON" PATENT SECTIONAL SUPERHEATER.

A Saving of

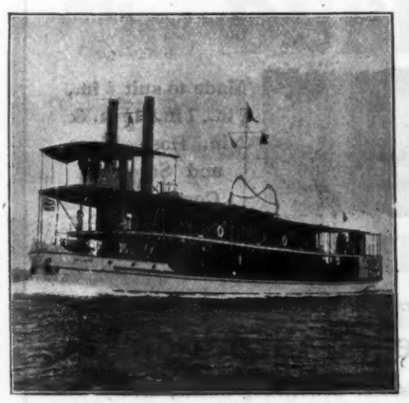
10% to 20% OF YOUR COAL BILL.

Standard Sizes for Immediate Delivery.

ASK FOR FULL PARTICULARS. 9407

JOHN Thompson WOLVERHAMPTON

Also Proprietors of "McPHAIL & SIMPSON" SUPERHEATER.



J. SAMUEL WHITE

AND COMPANY, LIMITED,

SHIPBUILDERS and ENGINEERS,

EAST COWES,

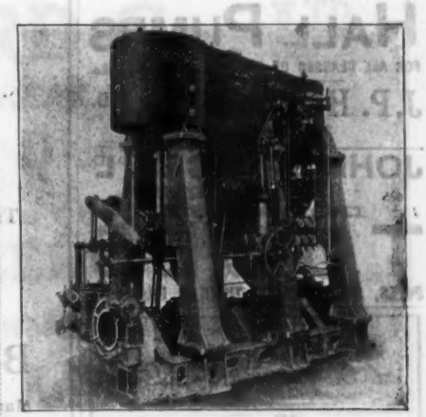
ISLE OF WIGHT.

TELEGRAMS: WHITE, EAST COWES. | TELEPHONE: No. 3 COWES.

LONDON OFFICE:

28, VICTORIA STREET, S.W. I.

TELEGRAMS CARNAGE, LONDON.
TELEPHONE No. 4507 VICTORIA.



BUILDERS OF

High-Speed Passenger Steamers.

Cargo Steamers.

Special Service Vessels.

Shallow Draught Vessels.

Torpedo Boat Destroyers.

Steam and Motor Launches of every class.

OIL FUEL BURNING INSTALLATION
LOW PRESSURE SYSTEM
REGISTERED
J. Samuel White & Company
TRADE MARK
LIMITED.
FOR MARINE & LAND PURPOSES

LIVERPOOL OFFICE:

310, ROYAL LIVER BUILDING.

TELEGRAMS - PROTECTION, LIVERPOOL.
TELEPHONE No. - 201 CENTRAL.

MANUFACTURERS OF

Marine Steam Turbines.

Reciprocating Engines.

"White-Forster" Water Tube Boilers.

Marine Return Tube Boilers.

"White-Diesel" Heavy Oil Engines.

The "J. Samuel White" Oil Fuel Burning Installation (Low Pressure System) for Marine and Land purposes. 9072

MECHANICAL STOKERS
COAL ELEVATORS &
CONVEYORS

ED·BENNIS·&·CO·LTD
LITTLE HULTON·BOLTON·&·28 VICTORIA ST. LONDON·S.W.1
LOOK OUT FOR FULL-PAGE ANNOUNCEMENT ON JULY 21

SUCTION & STEAM JET
ASH REMOVAL
PLANT

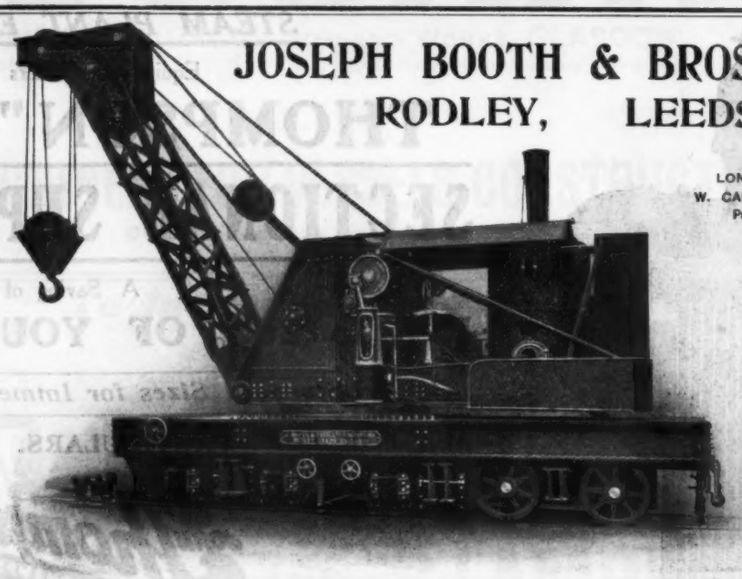
THE "STONE" SYSTEM
OF
HYDRAULICALLY OPERATED
WATERTIGHT DOORS.
As fitted to latest Mail and Passenger Steamers.
J. STONE & CO., LTD.,
Deptford, London, S.E. 765

CROSBY
SPECIALITIES.
SEE ADVERTISEMENT NEXT WEEK.
CROSBY VALVE & ENGINEERING Co., Ltd.
41-42, FOLEY STREET, LONDON, W.1

THE LEEDS ENGINEERING
AND HYDRAULIC CO., LTD.
RODLEY, near LEEDS. 9722
PUMPING AND HYDRAULIC MACHINERY, ETC.
SEE LARGER ADVERTISEMENT FORTNIGHTLY.

ELEVATORS, CONVEYORS,
FANS,
ETC.
W.J.JENKINS & Co.Ltd
ENGINEERS
RETFORD NOTTS.

JOSEPH BOOTH & BROS., LTD.,
RODLEY, LEEDS.



LONDON REPRESENTATIVE:
W. CAIRNS BOOTH,
Parliament Mansions,
Victoria Street,
London, S.W. 1.

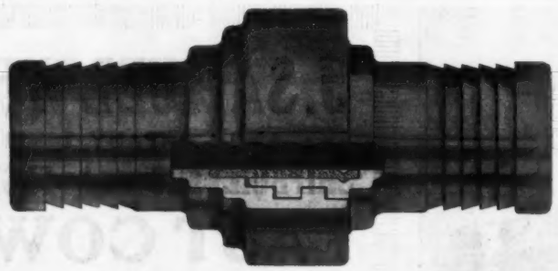
506

30 TONS
STEAM
BREAKDOWN
CRANE.

USE COLLIERY WASTE FUEL
MELDRUM FORCED DRAUGHT FURNACES
Will efficiently consume it and maintain your Steam Pressure at the lowest cost. Write for List No. 106 F. to us at Timperley, Manchester. 1013

A Reliable Hose Coupling at last!
Made from Steel Bar. Instantaneous Grip. Positive Lock. No Loose Parts.
PERFECTLY AIR-TIGHT AND INTERCHANGEABLE.

Suitable for Air or Water.
Saves Money, Time & Trouble.



Made to suit ¼ in., ¾ in., 1 in., 1½ in. & 2 in. Hose Pipes and Screwed Connections.

648

Ask for Particulars from the Sole Makers and Patentees:
Belliss & Morcom Ltd., Engineers, Birmingham,
Manufacturers of Steam Engines, Steam Turbines, Air Compressors, Condensing Plants, Heavy Oil Engines and Paraffin Engines.

HALL PUMPS
FOR ALL CLASSES OF BOILER FEEDING, &c., &c.
J.P. HALL & SONS, LD.
PETERBOROUGH.

JOHN SPENCER, LD.
WEDNESBURY.
655
IRON & STEEL
TUBES
POLES, STEAM MAINS, TUBULAR PILES, &c.

A. Reyrolle & Co., Ltd.
Switchgear. 9579 Hebburn-on-Tyne.

TOOLS
COLD SAWING MACHINES.
PLATE BENDING ROLLS.
PLATE EDGE PLANING MACHINES.
BEAM BENDING MACHINES.

9641
As supplied to British, Foreign and Colonial Governments.
CHAMBERS, SCOTT & CO., Ltd., Motherwell.

DO YOU WANT
HIGH GRADE
CRUCIBLE MELTED
MALLEABLE
CASTINGS?
Send your enquiries to 1736
The
OAK FOUNDRY LTD.,
Tiverton Road, Bournbrook,
BIRMINGHAM.

PRINCEPS & Co., SHEFFIELD. 604

LONDON OFFICE: 64, VICTORIA STREET, S.W.1.

AIR FILTERS. OIL EXTRACTORS. STEAM DRYERS. STEAM TRAPS.

RANSOME'S

NEWARK-ON-TRENT, England.

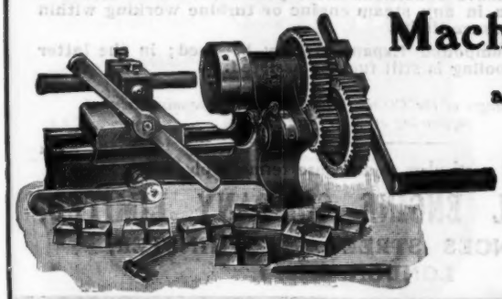
SAW-MILL Machinery.

Cask-making Machinery.

LONDON Office: 63, Queen Victoria Street, E.C. 4. 6814

S. A. DANIELL LIMITED,

Telegrams: "DANIELL, BIRMINGHAM." Telephones: 5405 and 5406, CENTRAL.

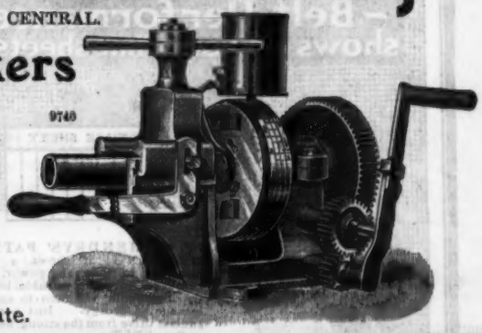


Machinists, Toolmakers and Ironfounders,

EDWARD STREET, PARADE,

BIRMINGHAM.

LONDON: 10, Camomile St., E.C.
GLASGOW: 272, Buchanan St.
MANCHESTER: 6, St. Mary's Gate.



9740

The DUBLIN DOCKYARD Co., LTD.

SHIPBUILDERS, ENGINEERS and REPAIRERS,

Alexandra Basin, North Wall, DUBLIN.

ALL MODERN APPLIANCES, including Electric, Pneumatic, and Oxy-Acetylene Plant for the **QUICK REPAIR** of

SHIPS, ENGINES, BOILERS.

Builders of all classes of VESSELS up to 400 ft., including HIGH-CLASS HOPPER GRAB DREDGERS.

4573

Telegrams (Day or Night): "DOCKYARD, DUBLIN." ON ADMIRALTY AND WAR OFFICE LISTS. Telephones: Nos. 23 and 24.

WALLSEND-ON-TYNE (Head Office).
Tel.: "News, Wallsend."

SUNDERLAND.
Tel.: "News, Sunderland."

LONDON OFFICE: 22, Billiter Street, E.C.
Tel.: "Nemerio, Fen, London."

LIVERPOOL OFFICE:
529, Tower Building, Water St.
Tel.: "Skilful, Liverpool."

Builders of RECIPROCATING and TURBINE ENGINES and BOILERS of all sizes.

The North Eastern Marine Engineering Co., Ltd.

8831

Manufacturers of the "NORTH EASTERN" SMOKE TUBE SUPERHEATER for Marine Boilers, and "NORTH EASTERN WERKSPOOR" MARINE OIL ENGINE.

Engines, Boilers, &c., Constructed for Export, and Fitting Out Supervised.

HAMMERED CAST IRON PISTON RINGS

By the Davy-Robertson Process.

All sizes from 2½ in. to 72 in.

— IN OUR —

SPECIAL PISTON RING IRON

Quick Delivery, Low Prices

Our Hammered Piston Rings are well and favourably known all over the world for their efficiency and long wearing qualities. They keep the cylinders round and maintain a perfect joint until worn out. The pressure on the cylinder wall always remains constant. 691

The Standard Piston Ring and Engineering Co., LTD.,

PREMIER WORKS,

Don Road, SHEFFIELD.

Telephone No. 2149.
Telegrams—Ocean, Sheffield.

"As an illustration of the lasting qualities of our rings, we may point out that a set of rings fitted in 1911, in a new commercial vehicle, have run 23,000 miles with a total wear in diameter of ·0064in.—wear on the cylinders was so slight that standard size rings have again been fitted after ten years use."

THE STILL SYSTEM OF COMBINED INTERNAL COMBUSTION AND STEAM ENGINE.

No. 2.

Steam, generated solely from the heat normally wasted by the Combustion Cycle in the Jacket and Exhaust, is utilised to increase the power of the Engine by expansion in the same cylinder on the opposite side of the combustion piston.

THE STEAM CYCLE.

(1) The Steam expands in a hot cylinder without condensation losses;
(2) Cools the combustion piston;
(3) Takes in heat therefrom during expansion;
(4) Exhausts at a slight superheat.
(5) Under the above conditions more power per lb. of steam is obtained than in any steam engine or turbine working within the same pressure limits.
(6) Simple or Compound Expansion may be used; in the latter case piston cooling is still further assisted.

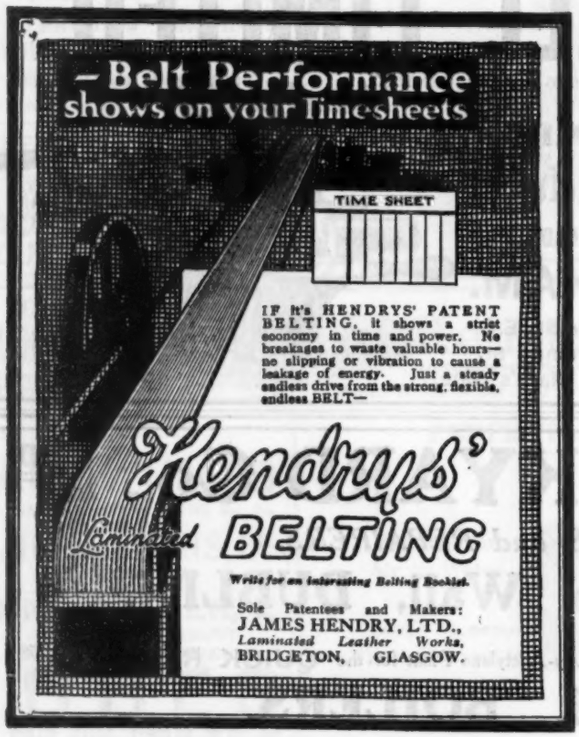
For the advantages of the COMBINED SYSTEM see advertisement appearing on July 14th, 1922.

9774

For full particulars and license terms apply to:—

THE STILL ENGINE COMPANY, LIMITED,

7, PRINCES STREET, WESTMINSTER,
LONDON, S.W. 1.


–Belt Performance
shows on your Timesheets
TIME SHEET
IF it's HENDRYS' PATENT BELTING, it shows a strict economy in time and power. No breakages to waste valuable hours—no slipping or vibration to cause a leakage of energy. Just a steady endless drive from the strong, flexible, endless BELT—
Hendrys'
Laminated
BELTING
Write for an interesting Belting Booklet.
Sole Patentees and Makers:
JAMES HENDRY, LTD.,
Laminated Leather Works,
BRIDGETON, GLASGOW.

9557

BARNARD'S PATENT GRABS

SOLE MAKERS:—

WM. GOODACRE & SONS, LTD.

VICTORIA DOCKS, LONDON, E. 16.

THE GRAB

CAN BE OPERATED FROM ANY TYPE OF CRANE AND NO EXPENSIVE FITTINGS REQUIRED.

HANDLES—

HEAVY & LIGHT ORES,
COAL & COKE,
SAND & GRAVEL,
MUD, CLAY,
CHALK,
STONE & ROCK

DREDGING

—SINGLE CHAIN OR WIRE ROPE

DOUBLE & TREBLE CHAIN or WIRE ROPE also SUPPLIED.

EXCAVATING

Telegrams—
"GOODACRE, LONDON."

Telephone—
EAST 1740 & 1.

705

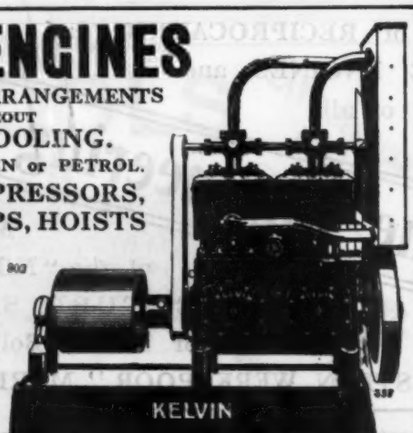
KELVIN ENGINES

70 STANDARD ARRANGEMENTS
WITH OR WITHOUT
RADIATOR COOLING.

3 to 60 HP. on PARAFFIN or PETROL.

For AIR COMPRESSORS, DYNAMOS, PUMPS, HOISTS

and all jobs requiring a power unit of absolute dependability. 802



Complete Manufacturers—

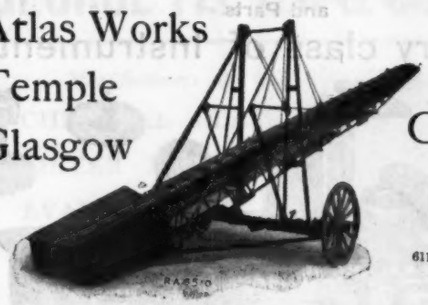
THE BERGIUS LAUNCH AND ENGINE CO., LTD.,

254, DOBBIE'S LOAN,

GLASGOW.

The Ritchie-Atlas Engineering Co.

Atlas Works
Temple
Glasgow



Runways
Cranes
Elevators
Conveyors
Dredgers
Loaders
Pilers
Tierers

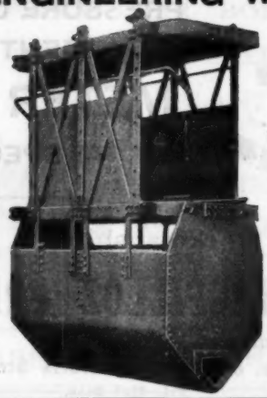
611

Makers of Transportation Plant

BOVING ENGINEERING WORKS, LTD.,

HEAD OFFICE:
56, Kingsway,
LONDON, W.C. 2.

WORKS:
STOKE-ON-TRENT.



PIT HEADGEAR
PIT CAGES
SKIPS
TANKS
KIBBLES

ELEVATORS
BUNKERS
HOPPERS
CONVEYORS

707

Tel.: BOVENTORK, PHONE, LONDON.
Phone: 6429 Holborn.

B. J. HALL & CO., LTD.,

Patent No. 170967.

The "HALL MARK" continuous Photo Printing Machine, recently designed to meet the present-day need for economical production. Working demonstrations by appointment, or full particulars on application.

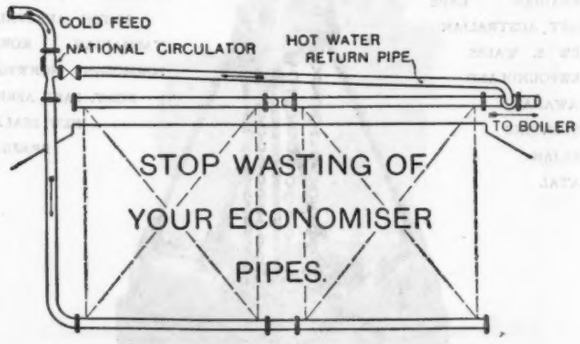
Branches—
BIRMINGHAM,
NEWCASTLE-ON-TYNE,
GLASGOW.

Head Office—
CHALFONT HOUSE,
GT. PETER STREET,
WESTMINSTER, S.W. 1.

647

NATIONAL PATENT ECONOMISER CIRCULATOR

FOR PREVENTING EXTERNAL WASTING OF ECONOMISER PIPES BY RAISING THE INLET TEMPERATURES OF THE FEED WATER



FOR FURTHER DETAILS WRITE FOR ILLUSTRATED PAMPHLET TO THE

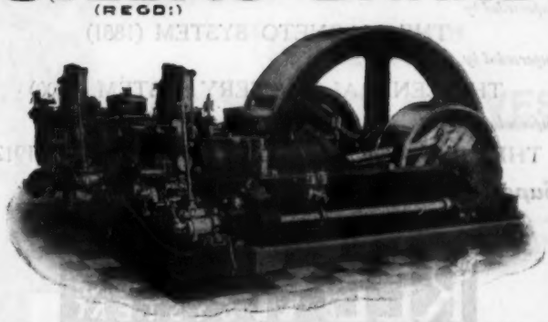
NATIONAL BOILER AND GENERAL INSURANCE CO., LTD.

(SALES DEPT.)
NATIONAL BUILDINGS,
ST. MARY'S PARSONAGE, MANCHESTER.

Telegrams: NATIONAL, MANCHESTER.
Telephone No: 2624 CENTRAL MANCHESTER. WITH DIRECT DEPARTMENTAL ACCESS.

9573

Improved Lubrication follows moderate feed of GRAPHITED OIL OILDAG BRAND (REGD.)



IN the cylinders of the engine illustrated 4 **drops of "OILDAG" Graphited Oil were substituted for 20 drops per minute of Plain Oil.** Perfect lubrication resulted and after several years of heavy duty lubricated with our Graphited Oil only, the engine is still in such excellent condition as speaks well both for the engine and the lubricant.

Please write for our new illustrated brochure dealing with this and our other Graphited Lubricants.

E. G. ACHESON, LTD.

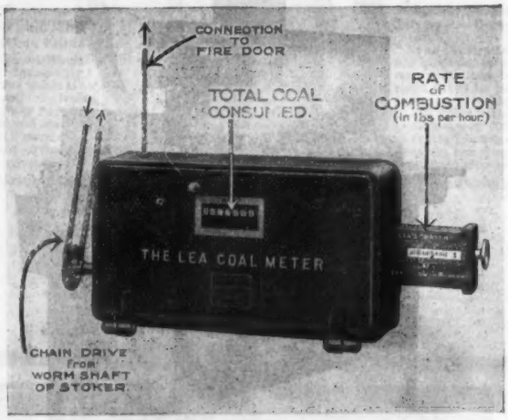
40, WOOD STREET, WESTMINSTER, LONDON, S.W. 1.

748

COAL-FLOW INDICATORS

for

CHAIN-GRATE STOKERS


CONNECTION TO FIRE DOOR
TOTAL COAL CONSUMED.
RATE OF COMBUSTION (in lbs per hour)
THE LEA COAL METER
CHAIN DRIVE from WORM SHAFT OF STOKER.

COMBINED METER AND INDICATOR

(1). The above illustration shows a Standard LEA COAL METER fitted with Patent "Rate of Combustion," or "Rate of Flow" INDICATOR, for observing instantaneously :—

THE CONSUMPTION OF COAL
IN
POUNDS PER HOUR.

(2). **INDEPENDENT INDICATORS** 693
without meters ALSO SUPPLIED.

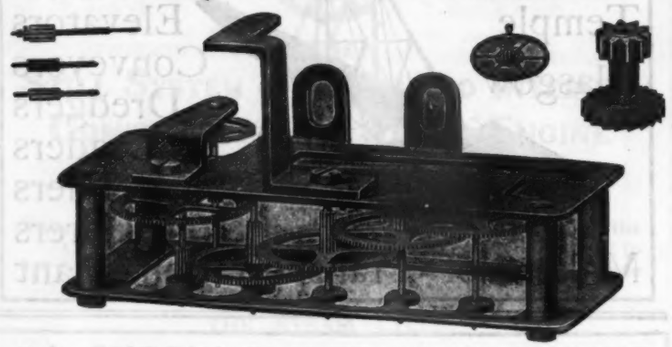
Full Particulars from :—

THE LEA RECORDER CO., LTD.,
28, DEANSGATE :: MANCHESTER.

SMALL GEARS

and Parts

for every class of Instrument.



PRESSURE GAUGE MOVEMENTS AND

METER TRAINS

A SPECIALITY.

Highest Class Workmanship. Lowest Prices.

DANIEL CHARPILLOZ FRERES & CO.

Sole Representatives— 617
C. S. & R. Grose, 63, Queen Victoria Street, London, E.C.
Tel.—8105 Bank.

TELEPHONE PROGRESS.

IT is interesting to note the way in which the modern system of telephonic communication has evolved. The table given here shows the progress of improvements in accordance with the dates that the various classes of Public Telephone Exchange were opened in England.

THE LOCAL BATTERY SYSTEM (1879)

Superseded by

THE MAGNETO SYSTEM (1881)

Superseded by

THE CENTRAL BATTERY SYSTEM (1900)

Superseded by

THE MECHANICAL AUTOMATIC SYSTEM (1912)

Superseded by

"The RELAY" AUTOMATIC TELEPHONE SYSTEM
SPEEDY · SECRET · SIMPLE · INFALLIBLE

which "The Liverpool Courier," the first newspaper to install a "Relay" system linked up with the public service, says is "the simplest, the quickest and in every respect the most effective for all purposes which the wit of man has yet devised."

The G.P.O. will supply on rental Private Automatic Exchanges on the "Relay" System connected to the public service.

Write for Booklet No. 37.

THE RELAY AUTOMATIC TELEPHONE Co., Ltd.
Marconi House, Strand, London, W.C. 2.
730

PRIESTMAN GRABS

HAVE BEEN ADOPTED BY THE FOLLOWING

GOVERNMENTS:

BRITISH, FRENCH, ITALIAN, SPANISH, INDIAN, GERMAN, CANADIAN, CAPE, WEST AUSTRALIAN, NEW S. WALES, NEWFOUNDLAND, HAWAIIAN, ARGENTINE, CHILIAN, NATAL, DUTCH, RUSSIAN, CHINESE, JAPANESE, PORTUGUESE, DANISH, VICTORIAN, QUEENSLAND, SOUTH AUSTRALIAN, TASMANIAN, KOREAN, FORMOSAN, NORWEGIAN, PORT. EAST AFRICAN, NEW ZEALAND, BRAZILIAN

9065

MANY REPEAT ORDERS.

Dock and Harbour Boards for DREDGING.
The Leading Contractors for EXCAVATING.
Steel and Iron Works, Collieries, etc., for ELEVATING.

PRIESTMAN BROS., LTD., HULL, And VICTORIA STREET, LONDON.

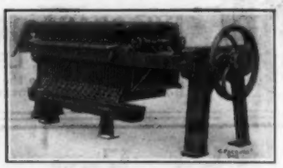
GEORGE FLETCHER & CO., LTD.

Manufacturers of

CHEMICAL PLANT
FILTER PRESSES
EVAPORATORS

HEAVY CONVEYORS
MINE VENTILATING FANS
PIT CAGES

MULTITUBULAR BOILERS
BALL & TUBE MILLS
CONDENSING PLANT



SUGAR MACHINERY
HEAVY ENGINEERING WORK
CASTINGS & PLATE WORK

MASSON WORKS, DERBY.

When You Buy Coal

are you *sure* that you are getting the value you pay for?

Presumably you buy on an analytical basis in accordance with modern practice, but *do you prove the figures* for yourself? It is very easy and many large consumers are finding it well worth while.

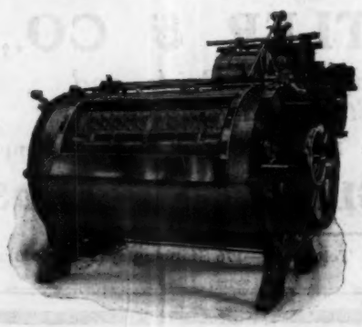
The essence of the operation is to obtain a *really* representative sample, or the result of the tests may be very misleading. Sturtevant Coal Samplers are specially designed for this duty. With these machines you really *know* what you are buying.

Write for Descriptive Leaflet No. "D. 1742."

STURTEVANT
ENGINEERING Co. LTD.
149 Queen Victoria St., London E.C.4

9043

STEAM LAUNDRY MACHINERY.



9710

Complete plants or single Machines quoted for Home and Overseas Laundries.

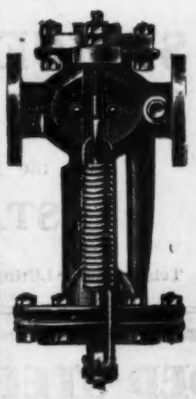
30 YEARS' EXPERIENCE.

D. & J. TULLIS, LTD.,
Steam Laundry Engineering Specialists,
CLYDEBANK, N.B.

DAVID AULD & SONS, LTD.

WHITEVALE FOUNDRY,
GLASGOW.

TELEGRAMS—REDUCING GLASGOW.



AULD'S PATENT
"QUITETITE"
REDUCING VALVES

ENSURE
SIMPLICITY
ACCURACY
RELIABILITY
DURABILITY

ALSO SPECIALISTS IN
EQUILIBRIUM & EMERGENCY STOP VALVES
FULL BORE SAFETY VALVES, ETC.

SPECIFY—

8369

"AULD'S" VALVES.

BROUGHTON COPPER Co LD

WORKS: MANCHESTER AND DITTON (near Widnes).

COPPER SMELTERS. COPPER AND BRASS MANUFACTURERS.
FLUID-COMPRESSED-HYDRAULIC-FORGED
COPPER, BRASS AND BRONZE TUBES AND CYLINDERS
COPPER INGOTS. BARS. SHEETS &c. ELECTRO-COPPERING.

OFFICES: MANCHESTER. BRANCH OFFICES LONDON AND GLASGOW.

MANCHESTER.

507

W. B. BROWN & CO. (BANKHALL), LD

GLOBE WORKS LIVERPOOL.

9278

HIGH GRADE.

STEEL WIRE ROPES FOR ENGINEERING.

SEND FOR CATALOGUE.

609

OIL MILL MACHINERY
OF ALL DESCRIPTIONS.

HYDRAULIC
Rivetters, Flangers, Presses, Cranes, Railway Carriage and Wheel Machinery, &c.

MUSGRAVE BROS.,
Crown Point Foundry, LEEDS.
Contractors to the HOME AND FOREIGN GOVERNMENTS.

Hartness Flat Turret Lathes and Automatic Dies.

JONES & LAMSON MACHINE CO.,

9 & 10, Water Lane, Queen Victoria St., LONDON, E.C. 4.

The Fay Automatic Lathe.

779

LOCO. STEAM CRANE

with Special Jib for Dry Dock Use.

SAMUEL BUTLER & CO., Ltd.,

Steel Bridges and Roofs and General Structural Engineers.

(On the Lists of all the Principal British Railway Companies.)

STANNINGLEY, near LEEDS.

9787

Telegrams—"Lifting," Stanningley. Telephone—176 Stanningley (Private Branch Exchange).

SOLID WELDED STEEL

OIL TANKS

SOLID LD B WELDED TRADE MARK

Over one hundred years' experience has made a world-wide reputation for "T.B." solid welded steel work.

Personal and Prompt attention to all enquiries.

THOMPSON BROTHERS

(BILSTON) LTD.

BILSTON STAFFS

Established

741

BULL'S METAL & MELLOID CO. LIMITED.

HEAD OFFICE AND WORKS: YOKER, near GLASGOW.
TELEGRAMS: "MELLOID, YOKER."
BULL'S METAL.—Propellers, Bars, Sheets, Pump Rods, Valve Spindles, Condenser Stays & Plates, &c.
MELLOID. (Reg. Trade Mark and Patented.)—Condenser Tubes, Plates and Stays, Boiler Tubes, Stays and Plates, Fire-box Plates, Bars, Sheets, Valves, &c.
WHITE METALS.—Babbitts, Plastic, &c. 9707

THOS. SUDRON & Co., Ltd.

STOCKTON-ON-TEES. 699

MAKERS OF MARINE AND VERTICAL TYPE BOILERS. SHIPS' MASTS. TANKS. MOORING BUOYS, STEEL LADLES, TUBING, Etc.

FLEXO THE QUALITY LUBRICANT

LUBRICATING GREASES IN 9 DENSITIES
(ONE DENSITY FOR EVERY PURPOSE)

THOMAS & BISHOP LTD. GLASGOW
37 TABERNACLE ST. E.C.2 23 BATH ST

HAMWORTHY

OIL ENGINES, PUMPS and AIR COMPRESSORS.

THE HAMWORTHY ENGINEERING CO., LTD., 78, VICTORIA STREET, LONDON. 613

CROWN BOILER COVERINGS

96% EFFICIENCY 8360

SUTCLIFFE BROS. & BRYCE LTD.

Globe Works, Godley, Hyde, MANCHESTER.
London Works: Seal Wharf, Stratford, E. 15.

VIBRATIONS

(Machinery for the study and elimination of)
VIBRATION SPECIALTY CO.,
Harrison Building, Philadelphia, U.S.A.
Apply for New Booklet. 9679

CASTINGS.

Gunmetal—Phosphor & Manganese Bronze, &c.
Engine and Boiler Mountings.
Lighthouse and Fog Signal Engineers.
STEVEN & STRUTHERS
GLASGOW, SCOTLAND. 8042
See our Illustrated Advert. on June 9 & July 7.

STEEL CASTINGS

STEEL AND IRON FORGINGS.
THE DARLINGTON FORGE LTD.,
DARLINGTON. 729
Tele.: "FORGE, DARLINGTON." Tel. 2610
(*See advertisement, page 78, June 23.*)

STEAM TURBINES.

Richardsons, Westgarth & Co. Ltd.
HARTLEPOOL, MIDDLESBROUGH & SUNDERLAND.
See large Advertisement, May 26. 6340

Ask for D.S. 1122

The book which tells you all about Heating and Ventilating Workshops
Sturtevant Engineering Co. Ltd.
147, Queen Victoria St., London, E.C. 4.

ROBERT STEPHENSON & CO., LTD.

LOCOMOTIVE BUILDERS, DARLINGTON.
London Office:—17, Victoria St., Westminster.
LOCOMOTIVES for all gauges and services.
Telegrams—Rocket, Darlington; Allcorpe, London.
Nat. Tel.—700 Darlington; 660 Victoria.
Codes—A B C 5th Edition, Engineering Standards, Engineering Telegraph.
See our Illustrated Advt. last and next week.

STOCK BOILERS.

MOST MODERN "DISH-END" TYPE.
WITH CORRUGATED SECTIONS.

		W.P.	Shop No.
One	30' 0" × 9' 3"	150 lbs.	5764
Eleven	30' 0" × 9' 3"	160 lbs.	5749/53 & 5924/9
Three	30' 0" × 9' 3"	120 lbs.	6019/20 & 6027
Three	30' 0" × 8' 6"	120 lbs.	6017/8 & 6026
One	30' 0" × 8' 3"	175 lbs.	5984
Two	30' 0" × 8' 3"	160 lbs.	6028/9
One	30' 0" × 8' 3"	120 lbs.	6025
Four	30' 0" × 8' 3"	100 lbs.	5678
One	30' 0" × 7' 6"	180 lbs.	5967
Three	28' 0" × 7' 6"	160 lbs.	5792/4

All the above Boilers are built from "Siemens Martin" Acid Steel.
Repairs to all types of Boilers by first-class men. 9406
John Thompson (Wolverhampton), Ltd.
Ettingshall, WOLVERHAMPTON, Eng.

Reduce Your PAINTING Cost

by installing the Aerograph method of Painting and Varnishing. 9683

The Aerograph distributes the heaviest Enamels, Paints and Varnish far more evenly and rapidly than the old brush method.

THE Aerograph REGD. TRADE MARK

Catalogue and Information post free.
THE AEROGRAPH CO., LTD.
Inventors and Pioneers of the Spray Painting Process.
45, Holborn Viaduct, London, E.C.1.
BRITISH FROM THE FIRST.

BALL & ROLLER BEARINGS

R. & M.

FOR SILENT RUNNING AND HEAVY LOADS.

RANSOME & MARLES BEARING CO., LTD.,
NEWARK-ON-TRENT, 9680
TELEGRAMS: "BEARINGS," NEWARK.
PHONES: NEWARK 170 & 171.
ENGLAND.

TIMBER

AMERICAN HARD WOODS,
TEAK and MAHOGANY, HORNBEAM,
HICKORY, YELLOW and COLUMBIAN
PINE, RED DEAL, SPRUCE, FLOORINGS, Etc.
SAW MILLS & BENDING WORKS.
JOHN ASHWORTH & CO
TRAFFORD PARK MANCHESTER 9688

JOHN OAKEY & SONS, Ltd.

GENUINE EMERY, EMERY WHEELS
1206 EMERY CLOTH, for all Purposes.
Wellington Mills. GLASS & FLINT PAPERS,
WESTMINSTER BRIDGE ROAD,
LONDON, S.E. 1. BLACK LEAD, &c.

SIEBE, GORMAN & CO's

8636 DIVING APPARATUS
Sole Makers to the BRITISH ADMIRALTY.
SMOKE HELMETS
OXYGEN BREATHING APPARATUS
for Poisonous Air,
MEDICAL OXYGEN APPARATUS
and
AIR COMPRESSORS AND VACUUM PUMPS
IMMEDIATE DELIVERY.
187, WESTMINSTER BRIDGE ROAD, LONDON, S.E.
Telegrams: "Siebe, Lamb, London." Telephone No. Hop 2461 (2 lines).
Cables: "Siebe, London."

Contractors to THE ADMIRALTY & WAR OFFICE &c.

BLUNDELL'S LONDON COPPER & BRASS WORKS (1910) Ltd

West India Dock Road, Limehouse, E. and Tilbury Docks, Essex.
COPPER WORK in EVERY BRANCH.

ENGINEERS' COPPERSMITHS BRASS FOUNDERS BRASS FINISHERS PLUMBERS' COOKING UTENSILS TINNED & ENAMELLED WITH PURE TIN

HIGH-CLASS ENGINE & BOILER FITTINGS CASTINGS IN BRASS, BRONZE, GUNMETAL COPPER, ALUMINIUM & ACID RESISTING METALS

MAKERS AND REPAIRERS OF BREWERS' & DISTILLERS' MASHING, COOLING, FERMENTING & STORAGE VESSELS MANUFACTURERS & CONVERTERS OF PLANT

THE MAKING & REPAIRING OF COPPER ROOFING, CUPOLAS, COPPER CAP FANS, STEAM & HOT WATER JACKETED PANS & KETTLES, ALL KINDS A SPECIALITY

Marine and General Repairers

Phones: EAST 29 & TILBURY 55. Telegrams: "BLUNDELLS, FOR, LONDON"

FOR POWER TRANSMISSION.

THOMAS HART, Ld., Blackburn, England
Pamphlet "Rope Driving." Free. 9079

See illustrated advert. last week and next.

SMITH'S RELIABLE CRANES
THOMAS SMITH & SONS (RODLEY), LTD., NR. LEEDS.

AUGUST'S
MUFFLE FURNACES, LTD., HALIFAX.
FURNACES AND CORE OVENS.
See displayed advertisement in July 7. 9811

ELECTRO-MAGNETIC CHUCKS
FOR ACCURATE GRINDING.
RAPID MAGNETTING MACHINE CO., Ltd.,
CRESCENT, BIRMINGHAM. 09936

BRICK MAKING MACHINERY
Herbert Alexander & Co Ltd
Charmouth St.
LEEDS.

Are you getting
HIGHEST ECONOMICAL RESULTS OBTAINABLE,
if not, write 9434
FUEL OIL AND TAR BURNING SPECIALISTS,
HOOPER & WEYMAN,
PILGRIM HOUSE, NEWCASTLE-ON-TYNE.

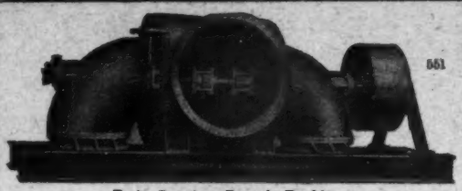
MAXWELL & FAGE.
(Successors to BRUCE & STILL, LTD.
49, Sefton Street, LIVERPOOL.
CONSTRUCTIONAL ENGINEERS & CONTRACTORS
for Steel Buildings, Bridges, Girders, and all descriptions of Structural Work. Timber Buildings designed for use at home & abroad.
See Illustrated Advertisement Preceding and Following Weeks
Catalogues, Designs & Estimates on application. 9007
Telo.: No. 1217 Royal. Telegrams: "Galvanizer," Liverpool

LODGE
SPARKING PLUGS
For GAS ENGINES. 9085
See Advt. page 75, June 9, and next week.

THE
MACFARLANE ENGINEERING CO., LTD., 860
Netherlee Road, Cathcart.
DYNAMOS & MOTORS.

FERGUSON BROS. (PORT GLASGOW) Ld.
PORT GLASGOW,
ENGINEERS AND SHIPBUILDERS.
Branch of the Amalgamated Industrials, Ltd.
See Last and Next Week's Half-page Illustrated Advertisement. 9214

KENYON'S PATENT OIL FILTER AND WATER SEPARATOR.
Over 900 ordered by H.M. Government.
ENGINEERS' STORES TOOLS.
ALEXANDER KENYON & CO., LTD.,
Victoria Bridge, MANCHESTER. 9787



Twin Gunther-Francis Turbine.

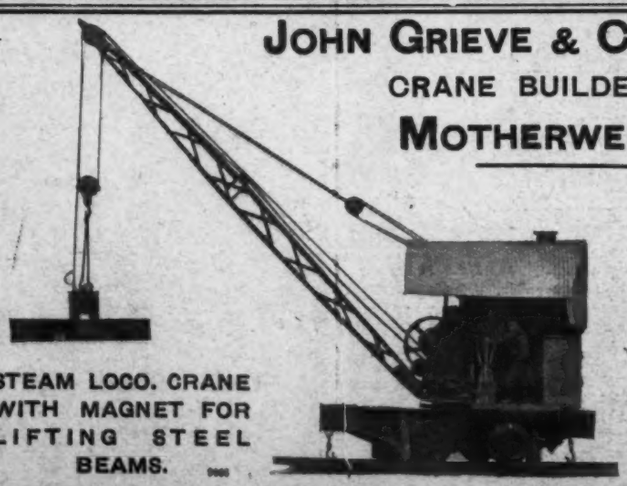
WATER
TURBINES
AND
PELTON WHEELS
W. GUNTHER and SONS,
Central Works, OLDHAM. 851

WEBB & SON, (COMBS) LTD.
Dept. 2, Combs Tannery,
STOWMARKET.
MANUFACTURERS OF OAK TANNED
LEATHER BELTING.
12 FIRST-CLASS AWARDS. 9073
Tanners & Curriers.
PRICE LISTS AND TERMS ON APPLICATION.

LANCASHIRE
BOILERS
IN STOCK & PROGRESS FOR EARLY DELIVERY.
WILLIAM WILSON & CO., 9257
LILYBANK BOILER WORKS, GLASGOW.

"THE LANCASTER"
SUPER-LIMIT PISTON RINGS.

No loose parts.
No tongue pieces required.
Specially designed to meet the increased pressures and speeds now obtained.
Illustrated leaflet on application.
LANCASTER & TONGE, LTD.,
Sole Makers of "The Lancaster" Steam Traps, Pistons, Limit Piston Rings, Steam Dryers, Machine Moulded Wheels, &c. O 8926
PENDLETON, MANCHESTER.



JOHN GRIEVE & Co.,
CRANE BUILDERS,
MOTHERWELL.
STEAM LOCO. CRANE WITH MAGNET FOR LIFTING STEEL BEAMS. 9000

The Turbine Furnace Co. Ltd.
238b, Gray's Inn Rd., W.C. 1.
UNIFORM AIR DISTRIBUTION Throughout Entire Grate Area.
See Illustrated Advt. Issue June 9th.

Rubber Mill MACHINERY
BERTRAMS LIMITED
Makers of EFFICIENT FOUNDRY PLANT
THE CONSTRUCTIONAL ENG. CO., LTD.
CHARLES HENRY STREET, BIRMINGHAM.
See half page advertisement, issue Aug. 19. 9077

J. TOMEY & SONS LTD.
EUREKA GAUGE GLASS
ESTABLISHED 1853
ASTON, BIRMINGHAM. 1437

A. BEEBEE,
Studs, Bolts, Nuts, &c.
WEDNESBURY. 3309

MICHELL BEARINGS, LD.,
ENGINEERS and MANUFACTURERS OF
Michell Thrust & Journal Bearings.
London Office: 9807
3, Central Buildings, Westminster.
See large Advertisement, page 110, June 9.

AILSA SHIPBUILDING CO.,
LIMITED,
Shipbuilders, Engineers, and Repairers, 9668
TROON and AYR.
See Displayed Advertisement last week and next week.

MAVOR & COULSON LTD
DYNAMOS · MOTORS · SWITCHGEAR
47 BROAD ST. · MILE END · GLASGOW

Measure your Screw Gauges accurately by using
B-L CYLINDERS & PRISMS.
Illustrated Booklet containing full particulars and prices post free from the makers, 8763
BASSETT-LOWKE, LTD. NORTHAMPTON.

REFRIGERATING MACHINERY
COLD STORAGE & ICE MAKING PLANT
H. J. WEST & CO., Ltd.
72-74 Grays Inn Rd., London, W.C.1

"BRITNIC"
— 4,000,000 HP. in Service. —
WATER TUBE BOILERS and MECHANICAL STOKERS.
(200,000 HP. in Service.) 9051
The British Niclausse Boiler Co., Ld.,
The Clock House, Arundel St., Strand, W.C.2.

W. G. BAGNALL, LD
STAFFORD.
BUILDERS OF LOCOMOTIVES
Weighing from 3 to 50 tons, for any gauge of Highest-Class Workmanship and Materials.
MAKERS OF 1899
Tipping Trucks, Sugar Cane Wagons, Turntables, Switches, &c.
See Illustrated Advert., page 92.

GOVERNORS

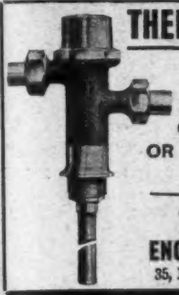
PICKERING TYPE.

737

IMMEDIATE DELIVERY.

HENRY HOLLINGDRAKE & SONS, Ltd., STOCKPORT.

THERMOSTATS



— for —
Controlling Steam to CALORIFIERS, OR HOT WATER TANKS. 698

THE HORNE ENGINEERING CO.,
35, Pitt Street, Glasgow.

PATENT PLANING, SHAPING & SLOTTING MACHINES.

SHAFTING, SURFACING & WHEEL LATHES.

See Illustrated advertisement May 5.

LOUDON BROTHERS, LIMITED, Johnstone, Glasgow & London

THE
CONSOLIDATED BRAKE & ENGINEERING COMPANY, LIMITED,
15, DEAN'S YARD, WESTMINSTER, S.W.
Manufacturers of the
STANDARD AUTOMATIC VACUUM BRAKE
and
Rapid Acting Service & Emergency Accelerators 9084
See Illustrated Advertisement June 23.
Telag.: "Vacuo, Vic. London." Tele. No.: Victoria 3867

THE
CLEVELAND BRIDGE AND ENGINEERING CO., LTD. 744
Specialists in the Design, Manufacture, and Erection of Bridges, Girders, Roofs, Warehouses, and all classes of Iron and Steel Constructional Work.
HEAD OFFICE AND WORKS—
DARLINGTON.

THE MITCHELL CONVEYOR AND TRANSPORTER CO., LTD.,
Contracting Engineers.

HANDLING MITCHELL PLANTS

Designers and Builders of all Classes of HANDLING MACHINERY. 9759
Atlantic House, 45-50, Holborn Viaduct, London, E.C. 1.
'Grams: Micontraco, Cent, London. Tel.: Holborn 926.

"SPLIT GRIP" COLLAR (TRIER'S PATENT)

AS USEFUL AS THE SPLIT PULLEY.

IN HALVES.

NO Set Screw to cause Accidents.

Grips like a Vice.

Fixed or Removed without Disturbance. 607

Sole Makers:
TRIER Bros.
LIMITED,
86, VICTORIA ST., WESTMINSTER, LONDON, S.W. 1.

"SHONE"
PNEUMATIC EJECTORS

For RAISING SEWAGE, SLUDGE, PAIL CONTENTS, &c.

AS USED AT
RANGOON, KARACHI, BOMBAY, EASTBOURNE, NORWICH, GOSPORT, HOUSES OF PARLIAMENT, Westminster, and many other places.

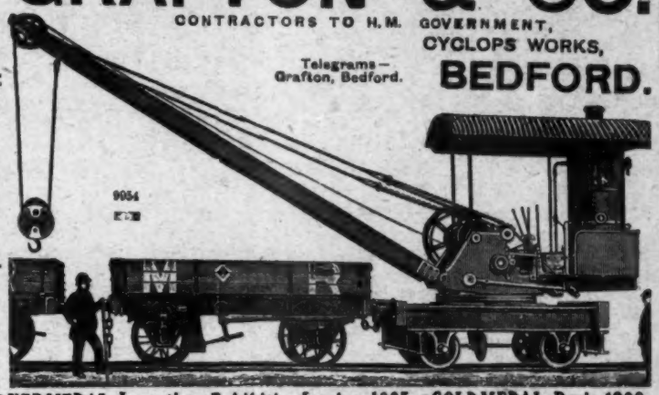
AIR COMPRESSING MACHINERY

COMPRESSED AIR LIFTS For Raising Water from Wells, Boreholes, &c.

For Pamphlets and full particulars apply to the Manufacturers—
9681
HUGHES & LANCASTER, Ld., 16, Victoria St., LONDON, S.W.

GRAFTON & CO.
CONTRACTORS TO H.M. GOVERNMENT,
CYCLOPS WORKS,
Telegrams— Grafton, Bedford.
BEDFORD.

Illustrated Descriptive Price List free on application.



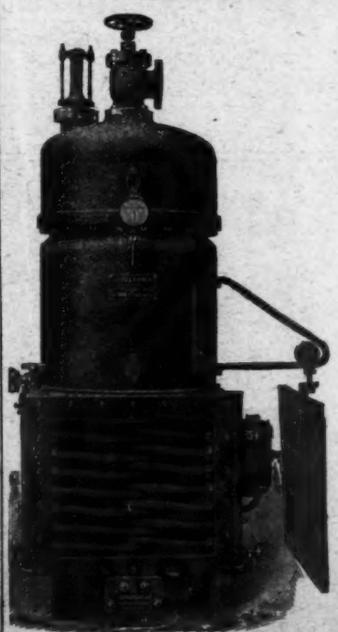
SILVER MEDAL, Inventions Exhibition London, 1885. GOLD MEDAL, Paris, 1900.
GRAND PRIX and GOLD MEDAL. Franco-British Exhibition, London, 1908.
GRAND PRIX, Buenos Aires Exhibition, 1910.

FOR
TIMBER 771

'Phone to— 24179 LEEDS.
Wire to— RANSFORD LEEDS.

Write to— G. R. CAWOOD & CO.,
4, South Parade, LEEDS (and Yorkshire Insurance Buildings, Lowgate, HULL).

CAIRD & RAYNER,
Admiralty and War Office Contractors.



PATENT
EVAPORATOR.
FRESH WATER FEED MAKE-UP APPARATUS.
Approved by Board of Trade for Passenger Ships

FEED WATER HEATERS.

FEED WATER FILTERS.

OIL SEPARATORS
Improved Type.

COMPLETE 9552
FRESH WATER DISTILLING INSTALLATIONS
(All Sizes) For LAND or MARINE USE.

BOILER FEED PUMPS.
Vertical Single-Cylinder Direct-Acting type.

777, Commercial Road, Limehouse, LONDON, E.

Tel. Address: "VAPORIER, LONDON." Telephone: No. 210 Eastern.

WILKINS & MITCHELL,
MAKERS OF RAPID PRODUCTION MACHINE TOOLS FOR ROLLING STOCK & BRIDGEWORK.
DARLASTON. 9659
For Illustrated Advt. see last and next week.

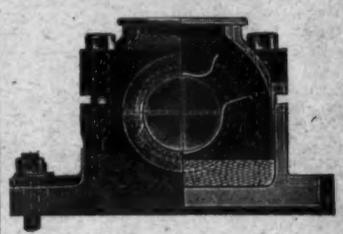
PULSATING PUMPS
TURNSTILES,
AND GENERAL ENGINEERING.

W. T. ELLISON & CO., LTD.,
Irlams-o'-th'-Height,
MANCHESTER.
Telegrams:—"Ellisons Ltd.," Irlams-o'-th'-Height.
Telephone: No 30, Pendleton. O 9606

OXY-ACETYLENE
WELDING
AND
CUTTING PLANT
MANUFACTURERS.
COMPLETE EQUIPMENTS.
4090
McGOWAN, WILD & CO.,
Lower Hurst Street,
BIRMINGHAM.
Tel.—1816, MIDLAND. Telag.—LOGIC, B'HAM.

POWER TRANSMISSION APPLIANCES

Large Stocks Ready for Immediate Delivery.



PATENT
SELF-OILING PLUMMER BLOCKS
(as illustrated).

Below we give net prices for a few standard articles:—

Dia.	1"	1½"	1¼"	1¾"	2"
Shafting (Bright, Turned) per ft.	1/-	1/2	1/5	1/9	2/2
Plummer Blocks, Cast Iron.	1/1	1/6	2/1	2/6	3/6
Plummer Blocks, Brass lined.	1/7	2/6	3/5	4/6	6/1
Plummer Blocks, Self-oiling.	1/9	2/9	3/9	5/-	6/9
Collars, Turned Steel.	1/3	1/6	1/9	2/-	2/6

Brackets.	Eccentrics, adjustable.
Bearings, cast iron.	Hangers.
" brass lined.	Lubricators.
" ball socket.	Pulleys, cast iron.
" self-oiling.	" wrot. iron.
" solid grease.	Shafting.
Collars.	Slings.
Couplings.	Stands, &c., &c.
Countershafts.	

9736
JOHN JARDINE LTD.
Deering Street, NOTTINGHAM.
Telegrams: "JARDINE, NOTTINGHAM."
Telephone: Nos. 3296 and 3266.

CAST-IRON ECONOMISERS FOR HIGH PRESSURES

GREEN'S ECONOMISERS

OF THE

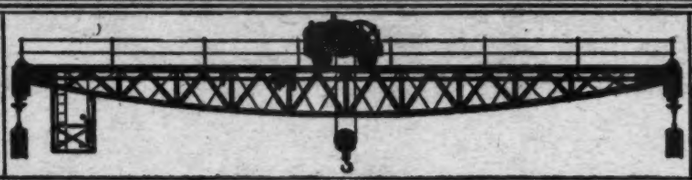
PATENT RINGSTAY TYPE

have been specially designed for extreme boiler pressures. This type is now working at many large Electric Light and Power Stations.

Full particulars on application. Write for booklet RE.

E. GREEN & SON, LTD., WAKEFIELD, ENGLAND. Telegrams: "Economiser, Wakefield."

CRANES OF ALL TYPES



GEORGE RUSSELL & Co LIMITED MOTHERWELL NEAR GLASGOW

A PUMP WITH A RECORD!

PULSOMETER ENGINEERING Co. LTD.

"For close on 40 years I have been engaged on wells of every description, and have had narrow escapes through inferior pumping tackle, but for the last 30 years, thanks to your Pumps, I have never had a failure either with the single pump or working them tandem, in fact I have had three in one well, two No 6 and a No. 5, so I have every reason to praise them."

WRITE FOR LIST No. 7.

LONDON: Offices: 11, Tothill Street, Westminster, S.W. 1.

READING: Works, Nine Elms Iron Works,

BRIGHT COMPRESSED

SHAFTING

ROUNDS. HEXAGONS. FLATS. SQUARES.

KIRKSTALL FORGE LTD., NEAR LEEDS.

TRADE MARK.

STEWARTS AND LLOYDS, LTD.

TRADE L&L MARK.

HEAD OFFICES:—41, Oswald Street, Glasgow. Broad Street Chambers, Birmingham.

LONDON OFFICE:—Winchester House, Old Broad Street, E.C.

Makers of WROUGHT IRON and STEEL TUBES

MAIN STEAM PIPE INSTALLATIONS. LIGHT TUBES with STEWARTS' INSERTED JOINT. COILS OF EVERY DESCRIPTION. OIL LINE PIPES

ASHFORDS PATENT TUBE WELL STRAINERS. STEEL CASTINGS. SIEMENS-MARTIN STEEL PLATES, ZINC SHEETS, ZINC BOILER PLATES.

Printed for the Proprietors by HARRISON & SONS, LTD., at the Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martins-in-the-Fields, and Published by CHARLES ROBERT JOHNSON, at the Offices of ENGINEERING, 35 & 36, Bedford Street, in the Parish of St. Paul, Covent Garden, both in the County of Middlesex.—June 30th, 1922.